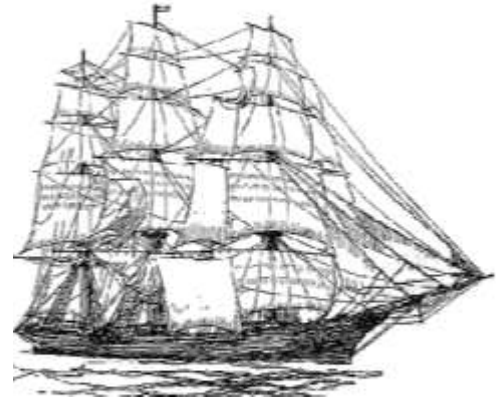
HARD HAT TRAINING SERIES

Introduction



The word rigging (from Anglo-Saxon *wrigan* or *wringing*, "to clothe") originally was a word used to describe the mechanical sailing apparatus (sails, masts, ropes, blocks and pulleys) used to propel a sailing boat or ship through the water. Today, the word rigging is used to describe any gear that is used for lifting. The quality of the material rigging gear is made from has changed drastically over the years. However, the principals of rigging remain the same.

Improper rigging practices have led to the deaths and injuries of many individuals. These are often due to riggers not knowing the correct method of securing certain loads, loading rigging components beyond their lifting capacities, and getting caught between unpredictable moving loads.

Training requirements

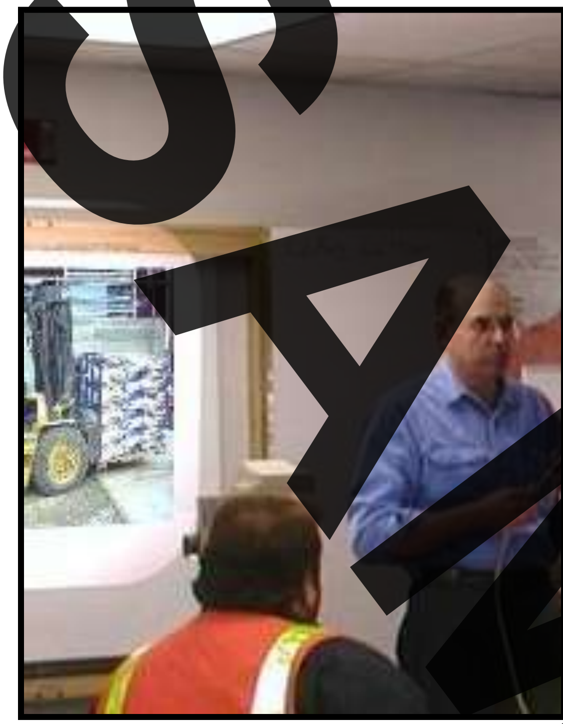
As part of this training we will analyze many of these accidents to discover what could have been done to avoid them.

Riggers must be trained and experienced. They must know how to:

- **Determine the weight of the load and its center of gravity**
- **Understand the stresses put on rigging gear when used in different configurations**
- **Select, inspect, and use slings and hardware suitable to the load**
- **Direct the crane and the load in a safe, efficient manner**
- **Know the limits and hazards of the cranes and equipment they work around**

Introduction

This training will be broken up into the following categories:



Determining the Weight of the Load;

Sling Angles and Stresses;

Center of Gravity;

Basic Sling Hitches;

Types of Lifting Slings;

Lifting Hardware;

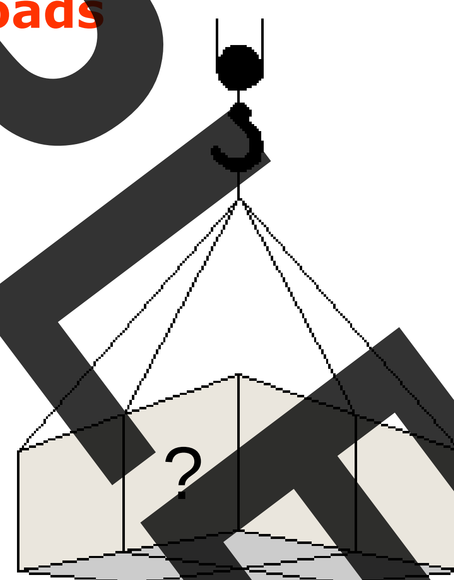
Below the Hook Lifting Devices;

Communication;

Crane Dynamics

Determining the weight of loads

In this section we will discuss the importance of knowing the weight of the load before attempting to lift it. This is the single most important precaution in hoisting and rigging. Everything depends on it, from using the load chart of the crane to picking the right capacity slings and rigging gear to lift it.



We will discuss methods of determining the weight of loads; the unit weights of common materials; how to calculate the volume of the load; and the challenge of lifting loads out of water.

Determining Weight

Weigh it

The most accurate method of determining the weight of the load is to weigh it. Although many cranes today have LMI (load moment indicators) that if calibrated will show the weight of everything below the boom tip and help prevent the operator from overloading the crane, it is important to know this information in advance so that the lift is planned properly. If you bring in a crane that has insufficient capacity then that is time lost.

Never attempt to proceed with a heavy lift if you have no idea what the load weighs or if you know you are overcapacity.

Often, the weight of the load can be obtained from data on manufacturing label plates, manufacturer documentation, blueprints or drawings, shipping receipts, bill of lading, stamped or written on the load and other dependable sources.

When such information is not available, it will be necessary to weigh the load or calculate its weight. Never use word of mouth to establish the weight of the load.

Math skills are required

Unfortunately, to be a qualified rigger you do have to have some math skill. There is no way getting around it. And, in reality, math is just a matter of knowing what different math terms mean (such as Pi or radius), knowing the correct formula to use, imputing the right data and then allowing the **calculator** to do the rest!

Always have a calculator on hand. Most cell phones have them as well as I-Phones, Blackberries, etc.

And, always carry a **field book** to jot down notes.

Note: Multiplying fractions on a calculator (such as 1/2 or 2/3) requires that they are converted into a decimal (0.5 or 0.666).

Also, when working with square feet it is necessary to convert inches into feet. (for example: 3 inches = 0.25 feet)

Calculating weight

To find the weight of any item you need to know its volume and unit weight and multiply them together. The unit weight is the density of the material and is normally measured in pounds per cubic foot.

Volume x Unit Weight = Load Weight

The time taken to calculate the approximate weight of any object, whether steel, plates, columns, girders, castings, bedplates, etc., is time well spent and may prevent a serious accident if any of the lifting gear fails.

Unit weights

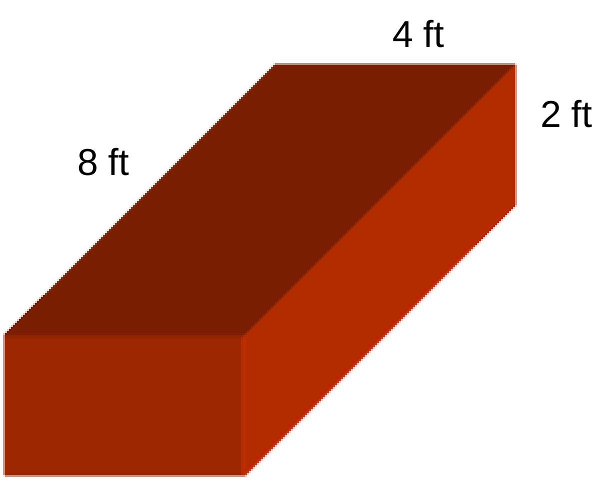
Here are the unit weights (lbs per cubic foot) of some common materials. Among the most popular to remember is the unit weights of steel (480 lbs), Reinforced concrete (150 lbs), Lumber (32-62 lbs) and water (63 lbs or 7.5 lbs per gallon).

As you can see, lumber is the tricky one. Fir is very light while Oak weighs almost twice as much. If you are not sure then it is important to estimate higher.

Note the weight of steel plate: ¼ inch steel plate is 10 lbs per square foot, ½ inch is 20 lbs per square foot, and so on.

WEIGHTS OF MATERIALS Materials & Liquids – lbs./cu. ft.			
Aluminum	165	Oil, Motor	58
Asphalt	81	Paper	58
Brass	524	Portland Cement	94
Brick	120	River Sand	120
Bronze	534	Rubber	94
Coal	56	Steel	480
Concrete, Reinf.	150	Water	63
Crushed Rock	95	Zink	437
Diesel	52	Pounds/sq.ft.	
Dry Earth, Loose	75	Steel Plate, 1/4"	10
Gasoline	45	1/2"	20
Glass	162	Alum. Plate, 1/4"	3.5
Cast Iron	450	7.5 gal./cu.ft.	
Lead	708	27 cu.ft./cu. yard	
Lumber, Fir	32	2000 lbs. = 1US ton	
Lumber, Oak	62		

Volume of a cube



To find the volume of a cube you need only to multiply its length by its width by its height.

To find its weight you need only multiply its volume by its unit weight.

Here is an example of a load of fir that is 8 ft long, 4 ft wide and 2 ft high. It's volume would then be 64 cubic ft and multiplying that by its unit weight of 32 lbs would give you a total weight of 2,048 lbs.

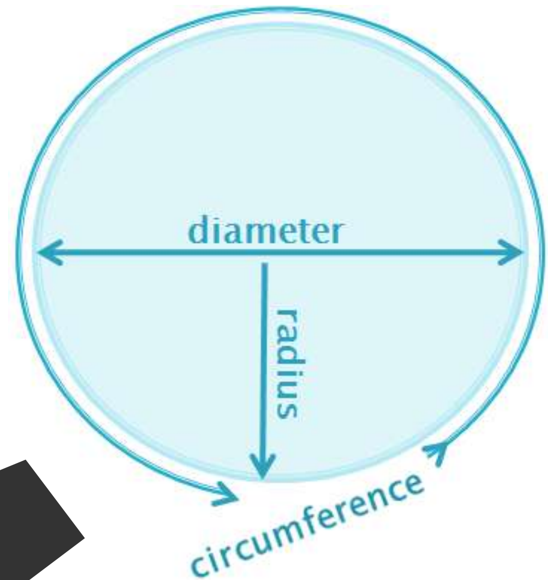
Complete exercise #1

Area of a circle

Determining the area of a circle is not difficult but it does require that we use such terms as Pi, Radius, Diameter, Circumference and Squared. Don't panic, if you have a calculator and some scratch paper it will be easy.

Pi = 3.14

Diameter is the distance across the circle at its widest point;



Radius is the distance from the center of the circle to the outside (or half of the diameter)

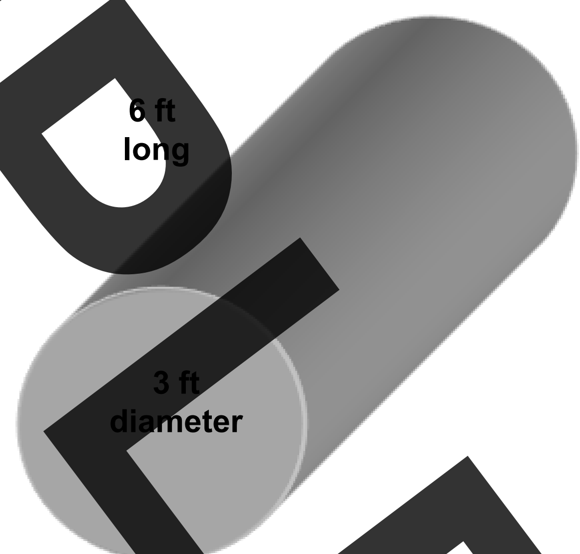
Circumference is the distance around the circle or Pi x diameter

Squared is multiplying a number by itself

Area = Pi x radius squared

Complete exercise #2

Volume of a cylinder



Determining the volume of a cylinder is easy once you know how to find the area of a circle. (Pi x Radius Squared = Area of Circle

All that remains is to multiply the area of the circle by the length of the cylinder. (Area x Length = Volume)

And finding its weight is just a matter of multiplying the volume by its unit weight. (Volume x Unit Weight = Load Weight

Complete exercise #3

What is the volume of this cylinder?

If it is concrete, what is its estimated weight? (Remember, the unit weight of concrete is 150 lbs per cubic foot)

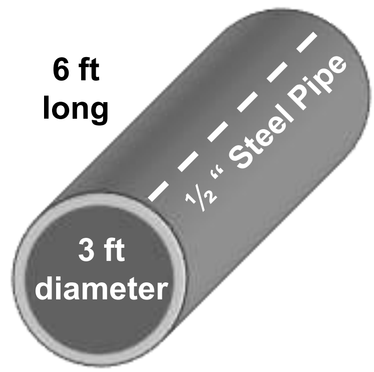
Determining Weight

Volume of a pipe

Now comes the hard stuff! Determining the weight of a pipe. Or is it hard?

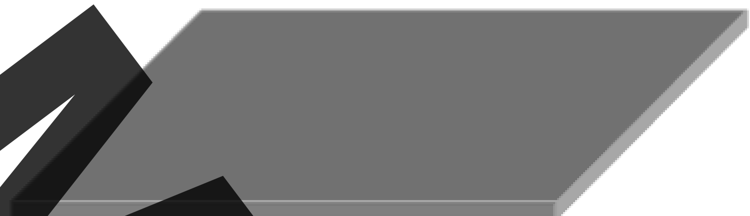
Here we are only interested in the volume of the material of the pipe, not the empty space inside it.

One way to do it is to determine the volume of the pipe as a whole as if it were a cylinder; and then determine the volume of the hole; and subtract the latter from the former.



This is where having a calculator comes in handy.

Easier yet, imagine that you split the pipe down its length and flatten it out into a rectangle. The circumference is now its width. Multiply its width times its length gives you its area. If this is ½" steel pipe then according to the rigging card its weight would be 20 lbs per square foot. So, its weight would be 20 lbs times the area. To summarize:

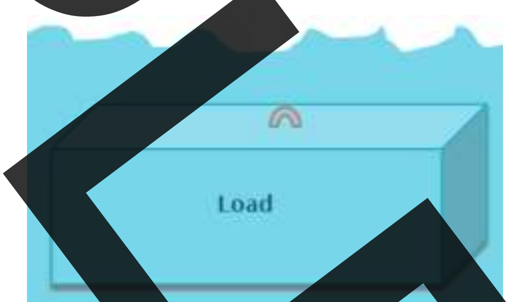


Circumference = 3.14 (Pi) x Diameter
Area = Circumference x Length
Weight of ½" Steel = 20 lbs per square foot
Area x 20 lbs = Weight of steel pipe

Complete exercise #4

Lifting out of water

Does a load weigh the same in the water as it does out of it? Yes, but it is easier to lift while in the water. Why is that?

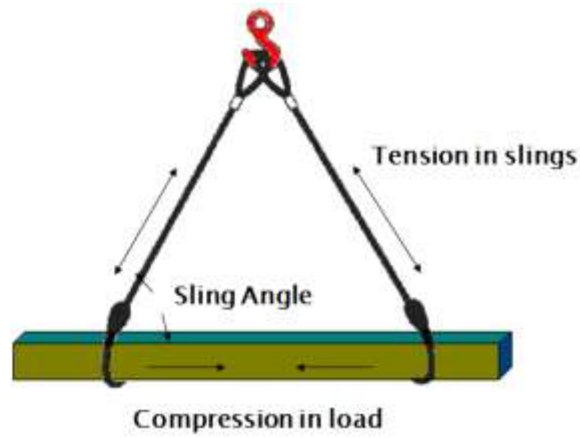


As the load slips under water it displaces a certain amount of water that is equal to its volume. This water has weight. So the amount of water pushed out of the way pushes back on the boulder providing it with a buoyant force.

How much? The force is equal to the weight of water displaced. **For example:** If we take our ecology block which weighs about 3,600 lbs and is 24 cubic feet and submerge it in water it will displace about 24 cubic feet of water.

Complete exercise #5

Sling Angles & Stresses



No one should be allowed to rig loads without knowing the stresses that are put on slings when lifted at angles.

When slings or sling legs are used at an angle while lifting a load, the capacity of the sling is reduced. The amount it is reduced depends on the angle of the sling.

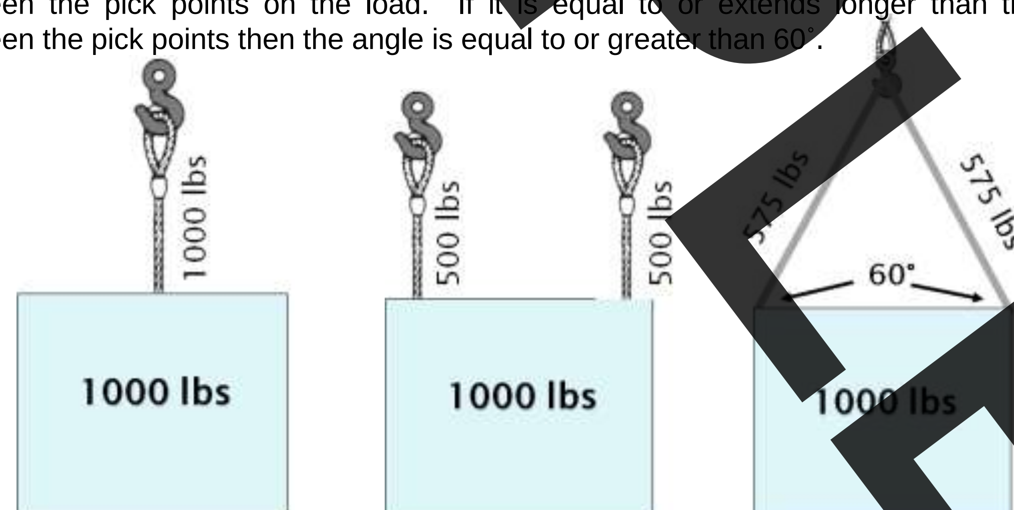
Sling angles can also put stresses on the load. When a rigger chooses a sling he must take into account not only the weight of the load it will be lifting but also the stresses it will see when used at an angle.

When a 1,000 lb load is lifted with one sling in the vertical we know that there will be 1,000 lbs of stress on that sling.

If we use two slings to lift 1,000 lbs and their legs are vertical (90˚) then each sling will see exactly half the load or 500 lbs.

When we marry two slings together on a hook, shackle or master ring then they will share the load equally, but because of the angle there will be added stress above the 500 lbs they saw in the vertical so its capacity will need to be reduced. The amount of reduction will be dependant on the angle. In this example each sling picks up an additional 75 lbs of stress at a 60˚ angle.

The ideal angle to use when using slings at angles is 60˚ since there is a minimum of reduction. One way to determine whether you have sling legs at 60˚ is to lay one down between the pick points on the load. If it is equal to or extends longer than the distance between the pick points then the angle is equal to or greater than 60˚.

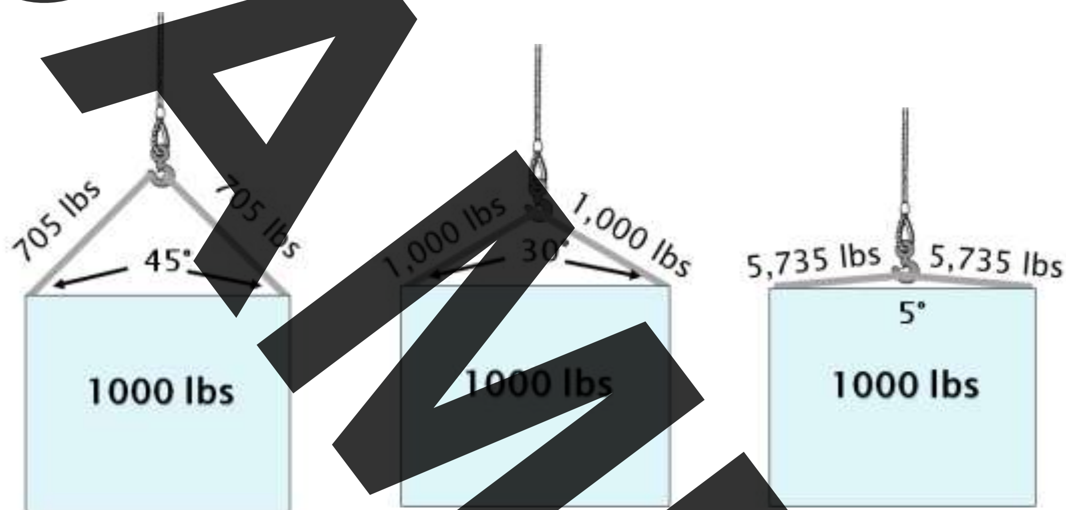


Sling angles

At a 45˚ angle each sling will see 705 lbs of additional stress so its capacity is reduced even further.

And at 30˚ each sling will see the equivalent of the whole load (1000 lbs).

And things go south as the angle of the slings are decreased to **5˚**. Now, there is an astounding 5,735 lbs of stress on each leg of the sling!



If we were using two slings whose capacities were 1,000 lbs in the vertical, (which would be plenty to pick up 1,000 lbs in the vertical or even at 60˚) there is a very good chance those slings would fail trying to use them at such an angle.

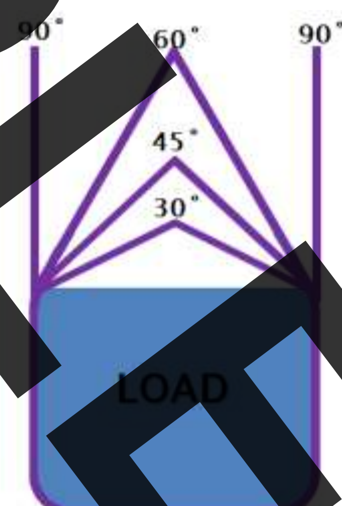
Load angle factors

To determine the amount of stress that the sling sees you need to:

Determine what the load angle factor is;

and multiply the load angle factor by ½ the load

Sling Angle	Load Angle Factor
90˚	1.000
60˚	1.155
45˚	1.414
30˚	2.000



Complete exercise #1

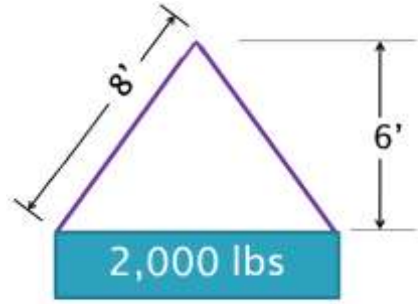
Sling Angles & Stresses

To calculate the load angle factor of slings of equal length, just divide the length of the sling by the vertical distance from the hook down to the load. (L/H)

Load angle factor = L/H
L/H x Load/2 = Stress in 1 leg of sling

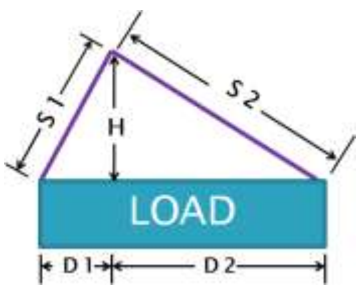
Complete exercise #2

Load angle factor



Unequal length sling legs

When the center of gravity is closer to one sling attachment point than the other, in order to position the hook over the CG , the sling legs must be of unequal length, which means that their angles and loads will also be unequal.



Caution: The sling that attaches to the point closest to the center of gravity will see the most stress. (This calculation may look difficult but it is not.)

Load x D2 x S1/[H(D1 + D2)]
= Stress in "S1"

Load x D1 x S2/[H(D1 = D2)]
= Stress in "S2"

Complete exercise #3

Drifting a load

Often, in tight quarters where bringing in a crane or forklift is impossible, a system is set up to drift a load using chain fall that is anchored into I-beams or a similar structure. This can be very dangerous if not planned and carried out by a qualified person.

Sling angles become very important because the stress can increase rapidly the higher the load has to be lifted. We will not address the issues of the structure or equipment used to perform such a lift here but rather concentrate on what stresses the slings will see as the load is moved.

Previously, in discussing sling angles, those angles were constant or did not change. In drifting a load those angles and stresses do change and it is critical that you know those stresses before you attempt such a lift.

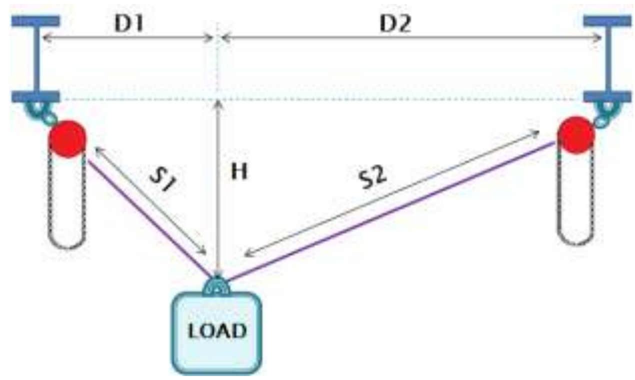
Sling Angles & Stresses

Drifting a load

This calculation is almost identical to the one for determining the stresses on slings of unequal length, just upside down!

The main difference is while drifting the load those stresses will change where one leg sees most of the stress and then it is transferred to the other leg.

Complete exercise #4

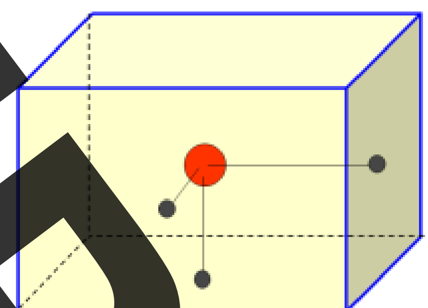


$$\text{LOAD} \times D2 \times \frac{S1}{H \times (D1+D2)} = \text{TENSION } S1$$

$$\text{LOAD} \times D1 \times \frac{S2}{H \times (D1+D2)} = \text{TENSION } S2$$

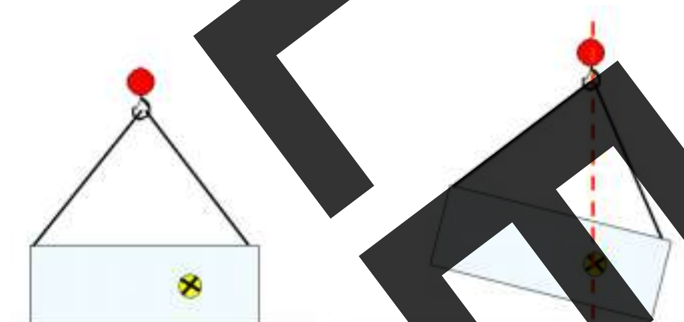
Center of gravity

The center of gravity (CG) as it pertains to rigging is the center of the load's weight distribution or the point in the load around which all weight is evenly distributed no matter how it is turned or rotated. This section we will mostly be talking about the effects the center of gravity of the load has on rigging.



Finding the center of gravity

When a load is rigged and lifted, the center of gravity will always move under the hook. If it is lifted abruptly, then it will swing past the CG and equal distance and then swing back and forth and so on. This can result in dangerous load shifting and additional stress on lifting hardware and rigging. If any load tilts more than 5° after it is lifted clear of the ground it should be landed and rigged over again.



Center of Gravity

Trial & error

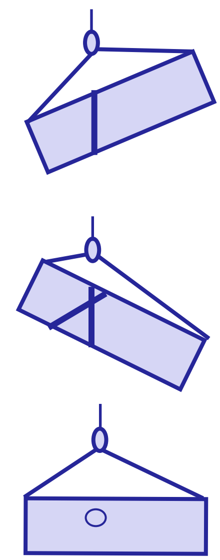
The "trial and error" method used to find the Center of Gravity is possibly the most reasonable.

1. On in initial pick, the load tilts to one side. Mark a line on the load in line with hoist line.

2. On the second pick, select slings of unequal length which will tilt the load in the opposite direction. Mark a line on the load in line with hoist line.

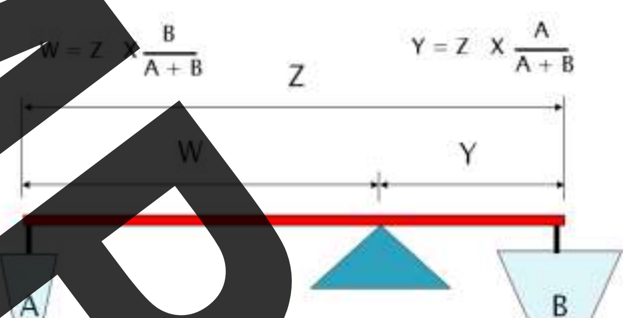
3. Where the two lines intersect is the Center of gravity in the horizontal (east/west)

4. Position the hook directly above the Center of Gravity and select the proper size slings.



Inverse proportion to distance formula

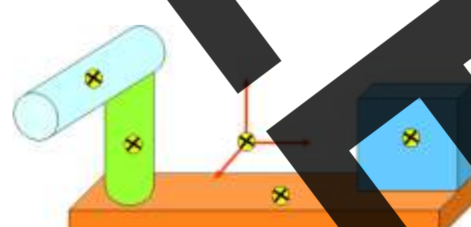
This formula will find the center of gravity of the load on a horizontal plane rather than in every direction and is good for long, wide loads where a two-legged bridle will be used to lift it. It is a simple formula that just requires that you know the weights of A & B and the distance between their center of gravities which is Z.



Complete exercises #1 & 2

Determining the Center of Gravity in the vertical uses the same process as for horizontal.

Determining the Center of Gravity in all three directions seems a little more mind boggling but just takes a little more time. Once you determine the CG in the horizontal, then calculate in the vertical. Draw a straight line between the two and the combined CG will be in the middle.



Center of Gravity

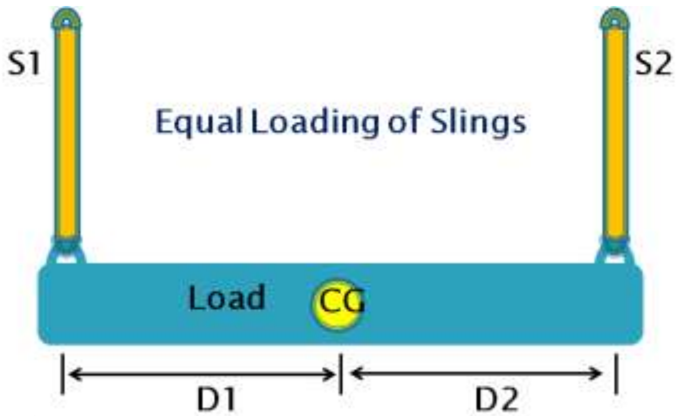
This formula is used to determine what the stress is in eacl vertical sling when picking up a loac where the slings are attached to a spreader bar or lifting beam.

The key to determining the stress on vertical slings is knowing the tota weight of the load; where its cente of gravity is and the distance between the two attachment points of the slings (not the length of the load).

What we will learn is that when the center of gravity is equally spaced between the two, then the stress on the slings will be equal But, let's do the math anyways!

When the center of gravity is no equally spaced between the two pick points the stress on the two slings will not be equal. The sling closes to the center of gravity will see the most stress.

Equal loading of slings



Complete exercise #3

Complete exercise #4

Pick points above CG more stable

Another important rigging principle is to ensure that the pick points of a load lie above its center of gravity. When a load is lifted it's center of gravity will always seek the lowest level below the hook. Loads where the pick points are below the center of gravity can be very unstable.

If you are attaching below the center of gravity you want to make sure the center of gravity is well within the triangle formed by the slings to make the pick.

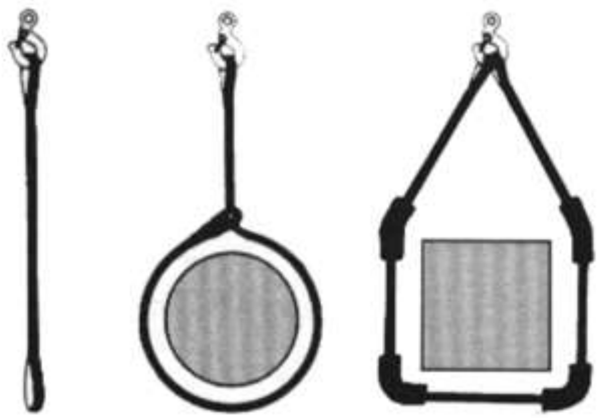
So, remember, if the attachments are above the center of gravity the load will be more stable. And if the attachments are below the center of gravity the load will be more unstable.

Rigging Hitches

3 Basic hitches

The three basic hitches are the Vertical Hitch, Choker Hitch and Basket Hitch. From these there are a multitude of variations that will allow the rigger to safely control the load during a lift. Typically, the choker is about 75% of the vertical capacity and the basket is double the capacity of the vertical.

Riggers should always remember that the type of hitch that's used to lift a load can greatly affect the rated capacity of the sling.



Capacity tags

Slings are required to have the tag showing the capacity of these hitches that they can be used in. The tag should also contain information regarding the manufacturer, description of the sling, material it's made from and its size.

If the tag is illegible or missing it should be replaced or the sling taken out of service.

Vertical hitch

Vertical hitches are either single-leg or multiple-leg bridles.

The Single Vertical Hitch supports the total weight of the load on a single leg (unless they are used in tandem on a spreader bar or lifting beam), and the sling angle is 90° (sling angle is measured from the horizontal) . It has one-leg loading and poor north/south, east/west control.

The single vertical hitch should not be used for lifting loose loads, lengthy material or anything difficult to balance. It also provides very little control over the load because it can allow the load to rotate unless it is controlled by a tagline. Single vertical hitches by themselves should only be used on loads where the bulk of the weight is concentrated directly below the hook and the load is equipped with a rated eyebolt, shackle or attachment point.

Bridle hitches

Two, three or four single hitches can be used together to form a bridle hitch for hoisting loads that are equipped with the rated attachment points.

Bridle hitches provide excellent load stability when: the load is distributed equally among the legs; the hook is positioned directly over the load's center of gravity; and the load is raised level. To distribute the load equally it may be necessary to adjust the leg lengths.

Proper use of a bridle hitch requires that the stress in the slings caused by sling angles be carefully measured to ensure that the sling is not overloaded.

2-Leg Bridles are excellent for picking long-wide loads. The capacity will vary depending on the sling angle.

3-Leg Bridles have excellent load control. If you are using a 3-leg bridle for a 2-leg pick then make sure the leg not being used is out of the way of the load.

4-leg bridles have excellent load control but only have the capacity of a 3-leg bridle since not all of the slings will carry an equal share of the load.

And if the load is very rigid, you must assume that the load is being carried by only two of the legs, so it must then be "rated" the same as a two-leg bridle. The other two legs will not see as much stress and will mostly help to balance the load.

The only way to get true, 4-leg loading is to have a way (a turnbuckle, for example) to adjust the tension in each leg. This method is really not practical since it would also require a way to measure that tension. It would be easier to make the reduction and use higher capacity slings if necessary.

Choker hitch

When a sling is being used in a choker hitch, there is a reduction in its rated capacity, usually around 75% of the vertical. For example: if the capacity of a sling in a vertical hitch is 12,000 lbs, then the capacity in a true choker hitch would be around 9,000 lbs. The key word here is "true."

Rigging Hitches

Another reduction that must be considered is due to the "angle" of the choke (not the angle of the leg of the sling).

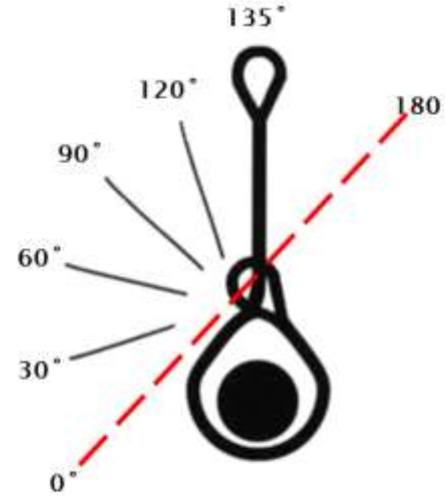
If the load is hanging free, the normal choke angle is approximately 135 degrees. This is a "true" choker hitch and is about 75% of the capacity of the vertical hitch.

When lifting and turning a load using a choker hitch, it is not uncommon to have a severe bend at the choke. When a choker hitch is used at an angle of less than 120 degrees, you must reduce the hitch's rated capacity as shown in the chart at right.

Similarly, it is not uncommon for riggers to "cinch" the eye of the choker tight to grip the load. This practice will also reduce the capacity of the "true" choker hitch.

If you need to better control of the load you may consider using a double-wrap choker instead.

Angle of choke



Angle of Choke	% of Capacity
120° – 180°	100
90° – 119°	87
60° – 89°	74
30° – 59°	62
0° – 29°	49

Complete exercise #1

Types of chokers

These are the different variations of chokers that are commonly used.

The Single Wrap Choker hitch forms a noose in the rope. It does not provide full 360° contact with the load and therefore should not be used to lift loads difficult to balance or loosely bundled. The single-wrap choker can also be doubled up to provide twice the capacity or to turn a load. (Doubling a single choker hitch is not the same as using a double choker hitch.)

Single-Wrap Choker

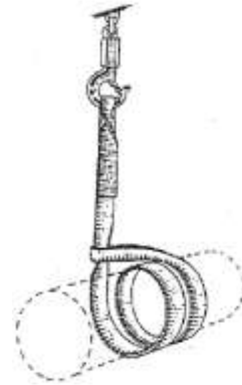
Average Load Control
Poor N-S, E-W

1 Leg Loading Reduced

Rigging Hitches

A double wrap choker is formed by wrapping the sling completely around the load and hooking it into the vertical part of the sling. This hitch is in full 360° contact with the load and tends to draw it tightly together. It can be used either singly on short, easily balanced loads or in pairs on longer loads.

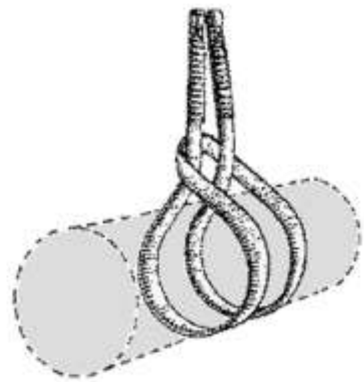
Double-wrap choker



Double-choker, eyes up

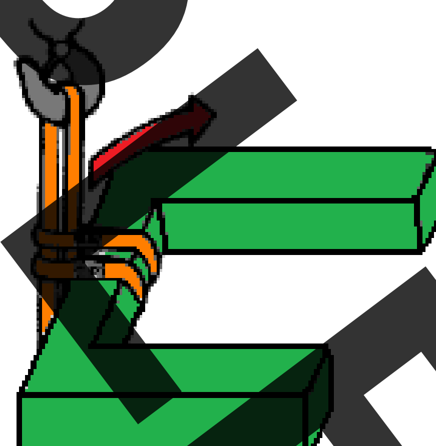
The double-choker, eyes up, is made by putting the eyes through the bite of the sling and hanging them on the hook.

If you are going to double up the slings into a double-choker it is better not to have the eyes up since the sling won't be able to adjust itself to get true 2-leg loading so one of the legs will be more stressed than the other, reducing its capacity.



Double-choker, bite up

The double-choker, bite up, is a better choice than eyes up since you will get true 2-leg loading.



Use a doubled-choker, bite up, to turn loads.

Single basket hitch

The Single Basket Hitch is used to support a load by attaching one end of the sling to the hook, then passing the other end under the load and attaching it to the hook. Ensure that the load does not turn or slide along the rope during a lift because both load and rope can be damaged.

Good Load Control
Poor N-S, E-W

2 Leg Loading

Lifting a load using a basket hitch allows the two legs of the sling to function as if they were two separate slings which will give you twice the capacity of a vertical hitch as long as the two legs are 90 degrees. For this to happen it would be necessary to use a lifting beam.

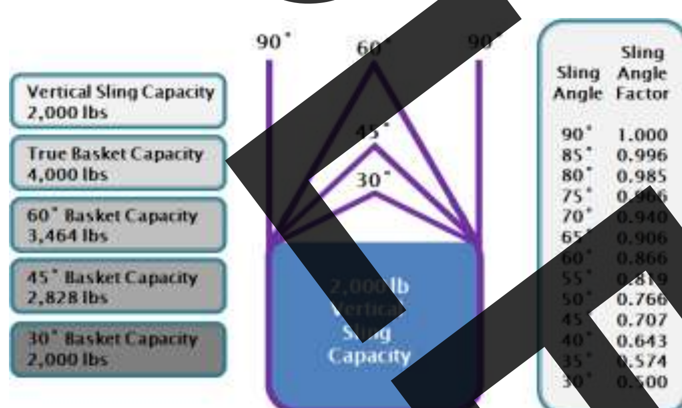
The Double Basket Hitch consists of two single basket hitches passed under the load. They must be placed under the load so that it is balanced. The legs of the hitches must be kept far enough apart to provide balance but not so far apart that low angles are created and the legs pull in toward the center. The angle between the load and the sling should be approximately 60° or greater to avoid slippage. On smooth surfaces, both sides of the hitch should be snubbed against a change of contour to prevent the rope from slipping as load is applied. Otherwise use a double wrap basket hitch.

Basket hitch deductions

If the sling capacity in the vertical was 2,000 lbs, then at 90° (true basket) it would be 4,000 lbs; at 60° it would be 3,464 lbs; at 45° it would be 2,828 lbs; and at 30° it would be 2,000 lbs.

Note: Sling angles of 60° or more are recommended; Sling angles less than 30° are highly discouraged.

Complete exercise #2



Capacity of Sling in Basket = 2 x Vertical Capacity of Sling x Sling Angle Factor

Rigging Hitches

Basket hitches

Here are four variations of the basket hitch: True basket, Reduced basket, Double-wrap basket and Inverted basket.

The basket hitch is more commonly used with both eyes attached to the hook which would be a reduced basket and the capacity would be less depending on the angle of the two legs. Like the vertical hitch the basket hitch is excellent for loads that have a pick point on top and whose mass is distributed directly under the hook.

The Double Basket hitch uses two basket hitches in a two-bridle.

Now there are two reductions to make: One reduction for the reduced basket hitch; and one reduction for the bridle hitch. The amount is reduced depends on the angle of the basket and the angle of the two legs.

Prevent sling slippage by keeping the angle between the load and sling 60° or more.

The double-wrap basket hitch is a basket hitch wrapped completely around the load and compressing it rather than merely supporting it, as does the ordinary basket hitch. The double wrap basket hitch can be used in pairs like the double basket hitch. This method is excellent for handling loose material, pipe, rod or smooth cylindrical loads because the sling is in full 360° contact with the load and tends to draw it together.

The reduced double-wrap basket hitch is most commonly used but a reduction in capacity is in order because of the angle.

The inverted basket's main advantage is that it adjusts on the hook so you get equal leg loading. The disadvantage is that it adjusts on the hook and so provides poor load control.

Good Load Control
Poor N-S, E-W
2 Leg Loading
Reduced

Good Load Control
Good N-S, E-W
2 Leg Loading
Reduced

Good Load Control
Good N-S, E-W
2 Leg Loading

Good Load Control
Good N-S, E-W
2 Leg Loading
Reduced

Poor Load Control
Slip N-S, Rotate E-W
2 Leg Loading

Slings Used For Rigging

Types of slings

In this section of the training we will discuss the different types of slings and the materials they are made from.

Synthetic Slings: are more pliable and easier to handle than metal slings. Because they are made of soft materials they will not damage loads. The most common types of synthetic slings are: **Flat slings** made of nylon, polyester or dacron; **Round slings** that are usually made from polyester; and **Rope slings** that are made from a multitude of materials such as polypropylene, spectra, and other newer, stronger materials that rival wire rope for its strength.

Wire Rope Slings: are typically constructed from high-carbon steel which comes in different grades, including Improved Plow Steel (IPS), Extra Improved Plow Steel (EIPS) and Extra Extra Improved Plow Steel (EEIPS), which designate the nominal strength of the wire rope. EIPS is most commonly used in the manufacture of wire rope slings.

Chain Slings: are your best choice for lifting materials that are very hot. They can be heated to temperatures of up to 1000ºF; however, when alloy chain slings are consistently exposed to service temperatures in excess of 600ºF, operators must reduce the working load limits in accordance with the manufacturer's recommendations.

Synthetic sling materials

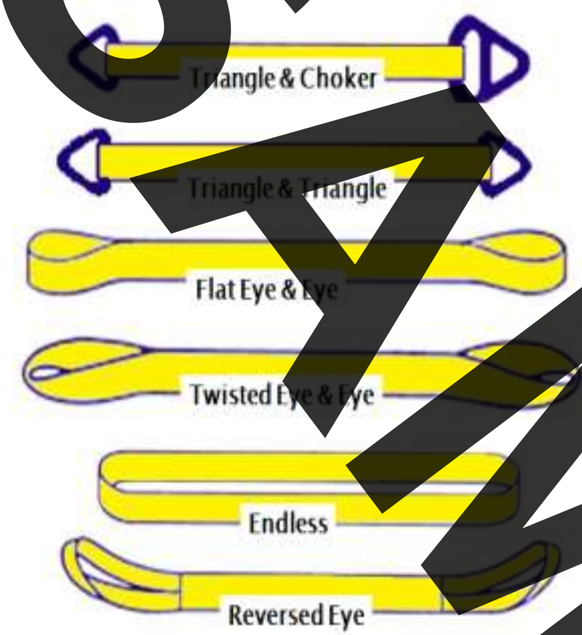
Nylon must be used wherever alkaline or greasy conditions exist. It is also preferable when neutral conditions prevail and when resistance to chemicals and solvents is important.

Dacron must be used where high concentrations of acid solutions - such as sulfuric, hydrochloric, nitric, and formic acids - and where high-temperature bleach solutions are prevalent. (Nylon will deteriorate under these conditions.) Do not use dacron in alkaline conditions because it will deteriorate; use nylon or polypropylene instead.

Polyester must be used where acids or bleaching agents are present and is also ideal for applications where a minimum of stretching is important.

Flat slings have multiple types of eyes that can be formed as well as hardware that can be sewn into the eyes to make them more versatile.

Flat sling hardware



Hardware on each end produces the most effective choker hitch.

Hardware on each end for use in basket or vertical hitch.

Popular, versatile sling used in vertical, choker & basket hitches.

Eyes turned at a right angle to sling body. Forms superior choker hitch & allows better fit on crane hook in basket hitch.

Economical & adaptable sling with no fixed wear points. Used in all hitches.

Extremely strong & durable for continuous &/or abusive applications. Wear pads on both sides of body.

Web sling use

Synthetic web slings are a good choice where highly finished parts or delicate equipment must be protected from damage. The synthetic material has stretch and flexibility to help the slings mold to the shape of the load, gripping securely, while cushioning and absorbing shock more than a wire rope or chain.

They are lightweight and very easy to handle.

They are non-sparking, non conductive and can be used safely in explosive atmospheres.

Synthetic slings are typically not affected by grease, oil, moisture and certain chemicals.

Check with the manufacturer to determine which conditions apply to the exact material you are using.

Flat sling inspection

The first thing you want to check for when using a sling or inspecting it is to see if it has a capacity tag and that it is legible. Most tags will eventually become hard to read with time so when buying slings make sure they have a sturdy capacity tag that will stand up to normal wear and tear.

If the capacity tag becomes illegible the rest of the sling might be in equally poor condition. The tag must be replaced or the sling discarded.

Punctures and snags in slings are the most common damage. Usually this is caused by dragging slings across abrasive surfaces. Never set loads down on top of slings or pull slings out from under loads. Always protect slings when they are wrapped around sharp corners or protrusions.

Cut slings are usually caused from not protecting slings when wrapped around sharp corners. Often, when a load is lifted, the sling will slide to adjust itself on the load. If it is up against a sharp corner or protrusion then it could be cut or even fail.

Some nylon web slings have red threads that are sewn inside and if these ever become visible the sling should be discard.

Broken stitches usually occur when they are put against sharp corners or bent while in a tight choker. Always protect this part of the sling and do not place stitch patterns (laps) on hooks, around sharp corners, or at choker bearing points.

Do not be tempted to lengthen or shorten synthetic flat slings by tying knots.

Heat damage can come from temperatures above 194°F and affect both nylon and polyester slings. Heat damage can also be caused by friction. Often, in a choker or basket, if the load is not properly centered the sling will slide while being lifted trying to adjust. This friction can cause the sling to heat up and possibly fail.

Weld splatter is also lethal to synthetic slings. Do not weld anything hung from a sling. Keep synthetic slings away from areas where hot work is taking place.

Flat sling inspection

Ultra violet light (UV rays) can also damage nylon and polyester slings over time. When the slings start to look bleached it time to replace them. Store nylon and polyester slings in a dark, cool, dry location.

All synthetic slings, over time, will eventually start to chaff. Often, this will be in the bite of the sling if it is used in a tight basket most of the time.

Inspect chaffed slings often by bending them in the more worn areas to see if there is internal damage. If in one location the sling bends significantly easier than the rest of the sling then it is damaged and should be discarded.

Inspect the eyes of slings for cuts, chaffing and wear.

This eye failure is probably due to putting it over a sharp corner or forcing it over a hook or pick point that was too wide.

The eyes of the slings will last longer if there is chaffing material sewn into it.

Synthetic round slings

Synthetic round slings are very popular because of their flexibility, light weight and how they conform to a variety of shapes and loads. They are not as stiff as flat slings and hang on hooks and shackles without bunching up. Normally, they are made from polyester yarns that are protected in a Kevlar jacket.

This jacket will protect the load bearing yarns from cuts, snags and chaffing but will not protect them from high heat.

Although they are made in the endless configurations, an additional jacket can be sewn around the middle of the sling to turn it into an eye-to-eye sling.

Round sling inspection

Because round slings are made of synthetic materials they are prone to cuts, snags, and damage to the protective jacket covering.

Make sure the capacity tag is on the sling and is legible.

Do not be tempted to lengthen or shorten synthetic round slings by tying knots.

Check the sling for snags or cuts in the jacket which are usually caused by wrapping the sling around sharp corners without protecting the sling with softeners or chaffing material. Never lay loads on top of slings or attempt to pull the end of slings out from under the load or pallet.

If there is a cut in the jacket you almost have to assume that some of the load bearing polyester yarns are cut too.

If there are polyester yarns that are pulling out then the sling must be discarded.

Round slings can also be damaged by heat from friction, usually caused by the sling adjusting under a heavy load.

Synthetic fiber slings

Synthetic fiber rope slings are made from various types of rope material, including nylon, polyester, polypropylene, and spectra to name a few.

These slings are very common in the maritime industry where slings can be fabricated for different uses including rigging loads to be lifted by the crane. The rope is bought in reels and slings can be fabricated as needed for all types of loads.

The fabrication of these slings falls under the guidelines of chapter 9-4 of ASME B30.9 titled slings.

Fiber rope slings

Three Strand- The most common of all the rope constructions. They are composed of three strands laid up generally right handed and are the most popular products for the majority of applications. This is because of the low cost factor.

Eight Strand- Constructed from 4 left hand and 4 right hand strands which gives it perfect balance. This construction provides a flexible and tough rope which is totally resistant to kinking and works well on all classes of deck machinery.

Twelve Strand- Constructed from 12 individual strands braided together to form a high strength torque balanced rope. This easily spliced, non-rotating rope is flexible and coils easily, will not kink or unwrap and has high strength to weight ratio.

Double-braided- Two ropes in one. First the braided core is constructed. A second rope is then braided over it to form the cover. You then have two ropes performing as a single integrated strength member. Over 50% of the rope strength is in the well protected core. Half the strands are braided right hand and half left for total balance. Double braid construction offers size for size greater strength than conventional 3, 8, or 12 strand ropes. If has high splice strength. It is flexible wet or dry, new or worn and works well on deck machinery.

Fabricating fiber rope slings

The fabrication of these slings falls under the guidelines of chapter 9-4 of ASME B30.9 . It states:

The design factor shall be a minimum of 5:1

Splicing is the preferred method of fabricating eye-to-eye or endless rope components for slings

Minimum or 4 full tucks in 3 and 8 strand ropes

Rigging knots

Knots have been passed down for generations and are useful in rigging especially for preparing and securing loads. There is the old saying: "if you cannot tie a knot, tie a lot!" Well, knowing how to properly tie knots is another sign of a good rigger and that knowledge will come in handy over and over.

The **bowline** makes a reasonably secure loop in the end of a piece of rope. Under load it does not slip or bind. With no load it can be untied easily. Two bowlines can be linked together to join two ropes.

This half hitch, which in reality is full "hitch" (formed by two half hitches) is useful in securing a load under tension to a post or beam.

The clove hitch is typically used in conjunction with another knot since it can slip in some instances and can bind in others, so, should not be used by itself.

Using a rope to pull a pipe or spar can be difficult because you need all the gripping friction you can get to keep the knot from slipping off as you make the pull.

Once of the best knots for this type of task is a pipe hitch.

Wire rope

Wire rope is a type of rope which consists of several strands of metal wire laid (or 'twisted') into a helix. Initially wrought iron wires were used, but today steel is the main material used for wire ropes.

Historically wire rope evolved from steel chains which had a record of mechanical failure. While flaws in chain links can lead to catastrophic failure, flaws in the wires making up a wire rope are less critical as the other wires easily take up the load. Friction between the individual wires and strands further compensates for any flaws.

Wire rope slings

In America John A. Roebling introduced a number of innovations in the design, materials and manufacture of wire rope forming the basis for his success in suspension bridge building.

Wire rope is technically a machine with dozens of individual wires formed to move together as a load is lifted and set down. When a wire rope bends, each of its many wires slides and adjusts to accommodate the differences in length between the inside and outside of the bend, the sharper the bend, the greater the movement.

The use of wire rope slings for lifting materials provides several advantages over other types of slings. While not as strong as chain, it has good flexibility with minimum weight. Breaking outer wires warn of failure and allow time to react. Properly fabricated wire rope slings are very safe for general construction use.

They can be subject to kinks when used in tight chokers or baskets and should not be used where temperatures exceed 400˚F or below -60˚F.

Fiber core wire rope slings should not be used in temperatures above 200˚F, nor should they be subjected to degreasing or a solvent because of possible damage to the core.

Every wire rope has three basic components: the wires, strands and core. The core may be either fiber (FC) or an Independent Wire Rope Core (IWRC), which is actually a smaller wire rope within the strands of the outer wire rope.

The wires are typically constructed from high-carbon steel which comes in different grades, including Improved Plow Steel (IPS), Extra Improved Plow Steel (EIPS) and Extra -Extra Improved Plow Steel (EEIPS), which designate the nominal strength of the wire rope. EIPS is most commonly used in the manufacture of wire rope slings.

Wire ropes are identified by classifications based upon the number of strands and nominal number of wires in each strand. A 6 x 19 classification for example, includes six strands with each strand consisting of 15-26 individual wires. The six strands of a 6 x 37 class wire rope are constructed of 27-49 individual wires.

Wire rope slings

The nominal strength of a wire rope is the breaking strength of new, unused rope. When ordering wire rope, always request a copy of the wire rope certificate which will show the type, grade, nominal breaking strength and actual breaking strength. A portion of each batch of wire rope produced is actually pulled to its failure point and the figure noted on the certificate. Above is an example of a pulling machine used for testing.

The nominal strength of a wire rope should never be used as its working load since it is the point at which it will fail.

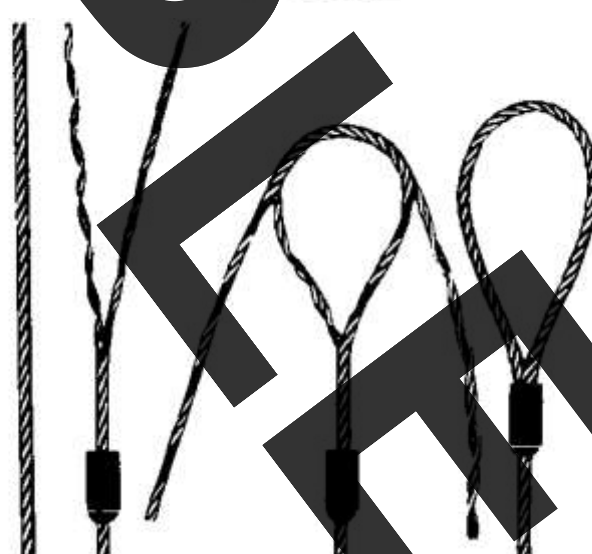
To determine the capacity of a wire rope sling, the nominal strength must be reduced by a design factor of 5. So, the capacity of a wire rope sling made from rope with a nominal strength of 20,000 lbs would be 4,000 lbs.

Hold on! Are you telling me that my wire rope sling that is rated for 4,000 lbs won't actually break until 20,000 lbs? Not really. Nominal strength begins to decline the first day of service due to natural causes such as surface wear, metal loss and fatigue. As time goes by, wire rope loses strength especially if overloaded, misused, damaged or improperly maintained.

Wire rope splices

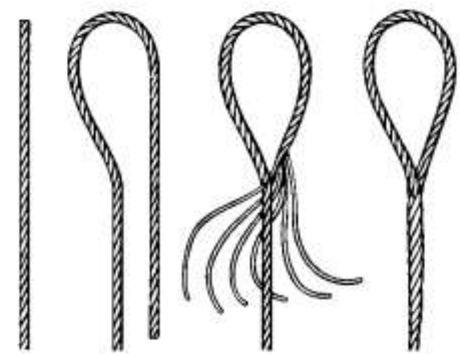
Most wire rope slings use either a mechanical splice to form eyes or a hand tucked eye.

A Mechanical splice is also know as a Flemish, Molly Hogan or a Farmers Eye and should be formed prior to swaging it. To make it, separate 3 strands from the other 3 strands and the core. Wrap them back onto themselves and trim the excess before swaging. The strength of this splice is in the splice itself and not in the swaged sleeve.



Slings Used For Rigging

Wire rope slings



Hand tucked wire rope splices to form eyes should be made be a qualified person.

One advantage of this eye as opposed to a swaged sleeve is that the eye is more flexible and because of its narrower profile it fits into tight spaces.

Care shall be taken to minimize sling rotation since they can unravel and fail if the sling is allowed to rotate during use.

Eyes can also be formed with a turn-back eye or cable-laid eye. The strength of these eyes depend upon the pressed swage or the torque of the wire rope clip for its strength. The eyes are prone to pulling out if not properly made so if possible, use a flemish splice.

Slings should not be made with wire rope clips unless there is no alternative.

Slings made with wire rope clips shall not be used in a choker hitch.

There are countless configurations that wire rope slings can be put into. Each has its advantages and disadvantages.

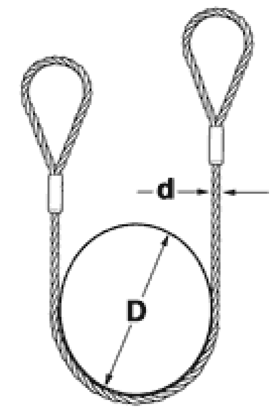
Braided Wire Rope Slings are usually fabricated from six to eight small-diameter ropes braided together to form a single rope that provides a large bearing surface, tremendous strength, and flexibility in every direction.

They are easy to handle and almost impossible to kink. The braided sling can be used in all the standard configurations and combinations but is especially useful for basket hitches where low bearing pressure is desirable or where the bend is extremely sharp.

The D/d ratio

Wire Rope Sling Reduction When Used in a Choker:

The D/d Ratio is the ratio of the diameter around which the sling is bent divided by the body diameter of the sling.



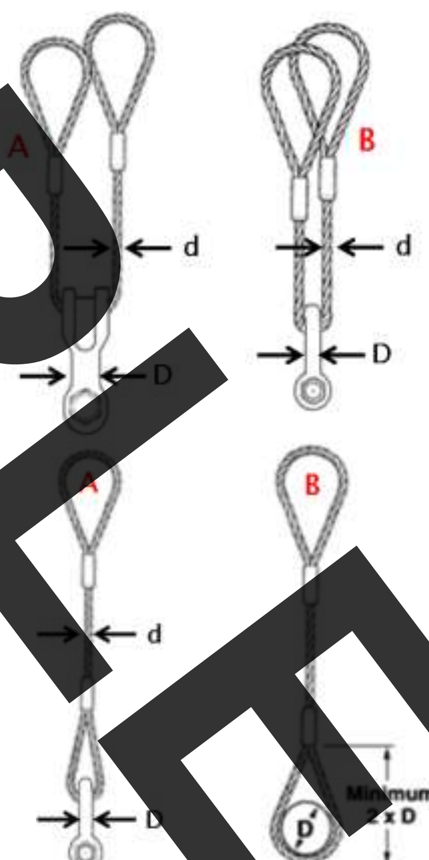
25:1 Ratio for full capacity

When a wire rope is bent around any sheave or other object there is a loss of strength due to this bending action. As the D/d ratio becomes smaller this loss of strength becomes greater and the rope becomes less efficient. This curve relates the efficiency of a rope diameter to different D/d ratios. This curve is based on static loads and applies to 6-strand class 6x19 and 6x37 wire rope.

If the object lifted with a 6-strand wire rope sling in a basket hitch is at least 25 x larger than the sling diameter (D/d 25:1) the basket capacity need not to be adjusted.

A) If the shackle or object has only 2 times the diameter of a 6-strand wire rope sling (D/d 2:1) the basket sling capacity must be reduced by 40%

B) It is better to use a larger shackle or a Wide Body shackle type. If the shackle or object has at least 5 times the sling diameter (D/d 5:1) the basket sling capacity must still be reduced by about 25%



The big D, little d applies also to the eyes of wire rope slings but is a 1:1 ratio instead of a 25:1 for a basket or choker

A) If the shackle body has AT LEAST the same diameter as the sling when attached to the eye (D/d 1:1) the capacity need not to be adjusted.

The real danger for wire rope sling eyes is putting an object in that is too large.

B) Eye length must NOT be smaller than twice the object diameter whether a shackle, pad eye or hook.

Slings Used For Rigging

Chokers should not be used on wire rope sling unless they have thimbles in the eyes, otherwise the eyes will become kinked.

The choke point should only be on the sling body, not on a splice or fitting.

A much better way to make a choker hitch in a wire rope sling is with a shackle. Be sure to put the pin of the shackle through the thimbled eye of the sling. Otherwise the action on the pin could cause it to unscrew.

Whenever two or more rope eyes must be placed over a hook, install a shackle on the hook with the shackle pin resting in the hook and attach the rope eyes to the shackle. This will prevent the spread of the sling legs from opening up the hook and prevent the eyes from damaging each other under load.

Wire rope sling inspection

Eventually, all wire ropes slings deteriorate to the point that they are no longer safe for use. The frequency of inspections, extent, and criteria for condemning wire ropes slings vary greatly for each type of service and environment.

As a sling suffers from the rigors of continued service both the design factor and the sling's ultimate strength are reduced. If a sling is loaded beyond its ultimate strength, it will fail. For this reason, older slings must be more rigorously inspected.

Wear gloves when handling wire rope.

Wire rope chokers

Slings Used For Rigging

Sling inspection

Wire rope slings must have a capacity tag that shows: manufacturer; description of the sling; capacity in the vertical, choker, and basket

Some companies color code their slings to show what the capacities are and post these codes in the area they are being used. If you do not know who the manufacturer is, or the capacity of the sling, it should be discarded

If ten randomly distributed wires in one lay are broken, or five wires in one strand of a rope lay are damaged, the sling must not be used.

(A rope lay is the length along the rope in which one strand makes a complete revolution around the rope.)

Pay special attention to broken wires and corrosion near the swage or fittings. Any broken wires in this area is reason to retire the sling. This area is very stiff and prone to breaks. Keep the sling lubricated.

Inspect the eyes of wire rope slings for broken wires, kinks and proper splicing. The choke point should only be on the sling body, not on a splice or fitting.

Although every rope sling is lubricated during manufacture, to lengthen its useful service life it must also be lubricated "in the field."

Most wire rope slings used in chokers, baskets and around sharp corners will start to get kinks and dog legs.

Evidence of "bird caging" or other distortion resulting in some members of the rope structure carrying more load than others. "Bird caging" is usually the result of overloading the rope and releasing the tension abruptly preventing the strands in returning to their original position.

Slings that start to look pigtailed have also been overloaded or used improperly.

Slings Used For Rigging

Wire mesh slings

Widely used in metalworking machine shops and other industries where loads are abrasive, hot or have sharp edges, such as bar stock or plate steel.

Mesh slings grip the load firmly without stretching, and the sling width greatly enhances load balancing. Since wire mesh slings are zinc plated they resist corrosion and most wire mesh slings are repairable so they can be very cost effective.

Wire mesh sling inspection

Overloading

All slings should be inspected for damage prior to each use to assure that their strength has not been compromised.

Overloading / Uneven Loading: Mesh does not lie flat, appears distorted and/or will not bend easily.

Wear

Wear: Flat areas on the individual wires. When wires have lost 25% or more of their original diameter, the sling must be taken out of service.

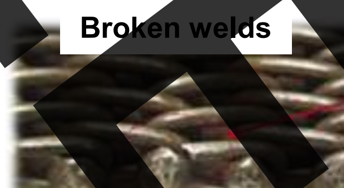
Distortion or Wear of End Fittings: Fittings that do not lie flat or have obvious areas of wear.

End fitting distortion

Corrosion/heat damage

Corrosion / Heat Damage: Areas of discoloration. Remove slings with wire diameter reduction of 15% or more. Slings exposed to temperatures of 550° F or more must be removed from service.

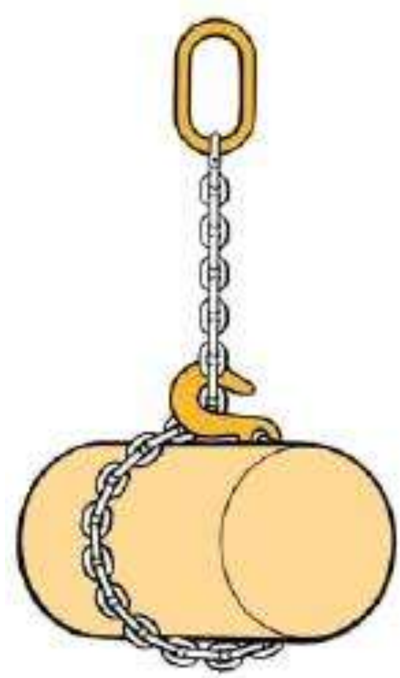
Broken welds



Broken Weld or Brazed Joint: A cracked or separation of the wire at the edge or in the body of the mesh.

Slings Used For Rigging

Chain slings



Chains are commonly used because of their strength and ability to adapt to the shape of the load. Care should be taken however when using alloy chain slings, because they are subject to damage by sudden shocks.

Chain slings are your best choice for lifting materials that are very hot. They can be heated to temperatures of up to 1000ºF; however, when alloy chain slings are consistently exposed to temperatures in excess of 600ºF, the working load limits should be reduced in accordance with the manufacturer's recommendations.

Misuse of chain slings could damage the sling, resulting in sling failure and possible injury to an employee.

Some chain sling bridles are adjustable allowing for different length legs.

Slings should never be shortened or lengthened by knotting or twisting.

Chain sling inspection

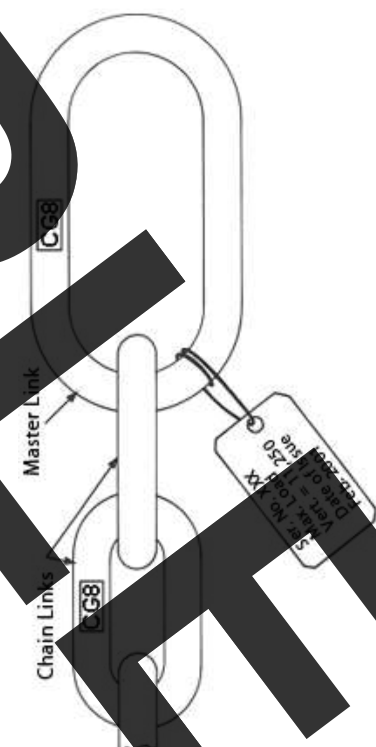
All chain slings must be visually inspected prior to use and should be thoroughly inspected link-by-link at least once per month.

A written record of the most recent periodic inspection shall be maintained and shall include the condition of the sling.

Closely examine each link. Remember, just one bad link can cause the chain to fail.

Under no circumstances should a chain be used for hoisting unless it has been closely examined for defects or wear.

Every chain should carry a small metal identification tag bearing a serial number and its safe working load.



Chain slings

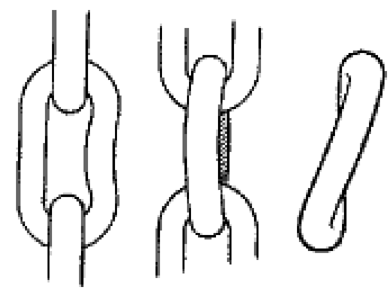
When inspecting alloy steel chain slings, pay special attention to any stretching wear in excess of the allowances made by the manufacturer, and nicks and gouges.

Whenever a chain is subjected to shock or impact loads, it must be immediately inspected before being put back into service

Look for bent, twisted or damaged links that often occur when the sling is used to lift a load having unprotected sharp edges.

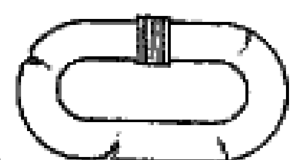
Look for elongated or stretched links. When the links are severely stretched, they tend to close up.

So, links that bind or a chain that will not hang perfectl straight may indicate stretch.



Binding is the term used to describe the condition tha exists when a sling has become deformed to the exten that its individual links cannot move within each othe freely.

Stretching should be determined by measuring with a caliper all new chains in sections of 1 to 3 feet and re-measuring them during inspection.



If the inspection reveals a stretch of more than 3%, take the chain out of service. Be particularly careful in determining link wear at the point where the links bear on each other.

Makeshift fasteners, hooks, or links formed from bolts, rods, or other such components shall not be used.

Mechanical coupling links shall not be used within the body of an alloy chain sling to connect two pieces of chain.

In addition, never attempt to repair the welded components on a sling.

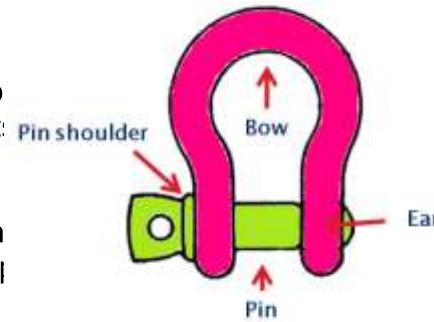
If the sling needs repair of this nature, the supervisor must be notified.

There are many types and styles of shackles and will divide them up into 3 common categories.

Anchor Shackle: The most common, is excellent fo attaching to master rings, hooks, pad eyes, eye bolts and wire rope slings.

Synthetic Sling Shackle: Has a wide bow tha accommodates wider, flat sling that tend to bunch up on anchor shackles.

Chain Sling Shackles: Perfect for use with chain.



The main components of a shackle are:

Shackle identification

Each new shackle body shall have forged, cast, or die stamped markings by the manufacturer to show

(a) name or trademark of manufacturer
(b) rated load
(c) size

Each new shackle pin shall have forged, cast, or die stamped markings by the manufacturer to show

(a) name or trademark of manufacturer
(b) grade, material type, or load rating

Anchor shackles

Screw pin shackles: are by far the most common used in lifting due to the ease of inserting and removing the pin.

Bolted shackles: are typically used for more permanent applications.

Round pin shackles: should not be used for lifting since the cotter pin will not withstand the side forces that are commonly put on shackles.



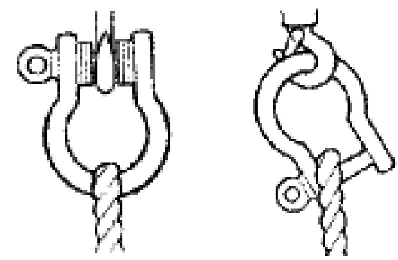
Shackle use

The screw pin threads shall be fully engaged and tight, and the shoulder should be in contact with the shackle body.

If a shackle is designed for a cotter pin, it shall be used and maintained in good working condition. For long-term installations, bolt-type shackles should be used; if screw pin-type shackles are used, the pin shall be secured from rotation or loosening.

Contact with sharp edges that could damage the shackle should be avoided.

Shock loading should be avoided nor should shackles be dragged on an abrasive surface.



The load applied to the shackle should be centered in the bow of the shackle to prevent side loading of the shackle.

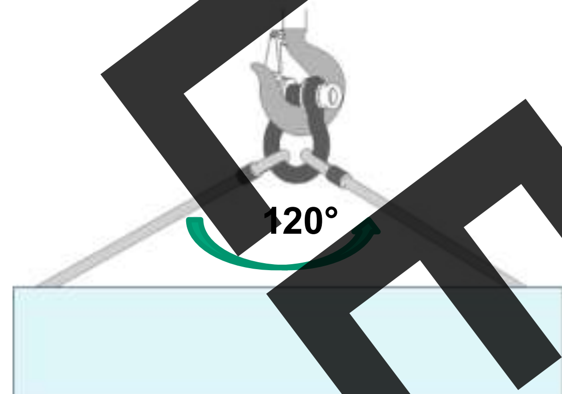
Multiple sling legs should not be applied to the shackle pin.

If the shackle is to be side loaded, the rated load shall be reduced according to the recommendations of the manufacturer or a qualified person.

The screw pin shackle shall not be rigged in a manner that would cause the pin to unscrew.

When a shackle is used in a choker hitch, the pin shall be connected to the choking eye of the sling.

Multiple slings in the body of a shackle shall not exceed 120-deg included angle.



Shackle inspection

Shackles shall be removed from service if damage such as the following is visible and shall only be returned to service when approved by a qualified person:

- missing or illegible manufacturer's name or trademark and/or rated load identification
- excessive pitting or corrosion
- a 10% reduction of the original or catalog dimension at any point around the body or pin
- indications of heat damage, including weld spatter or arc strikes
- excessive pitting or corrosion
- excessive nicks or gouges
- incomplete pin engagement
- excessive thread damage
- evidence of unauthorized welding
- other conditions, including visible damage, that cause doubt as to the continued use of the shackle

Eye bolts

Here are three categories of eye bolts:

Un-shouldered eye bolt: Used just for vertical picks. They should never be side loaded.

Shouldered eye bolt: Side loading permissible as long as done in the direction of the plane of the eye. Huge deductions in its capacity must be made when side loading.

Turned eye bolt: Good for clothes lines and tying up the dog but should never be used for lifting loads.

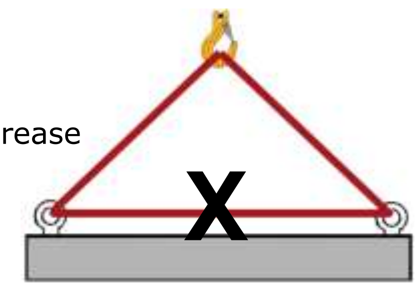
Eye bolts

Eye Bolts are marked with their thread size NOT with their rated capacities. Make sure you select the correct eyebolt based on its type and capacity for the lift you are conducting.

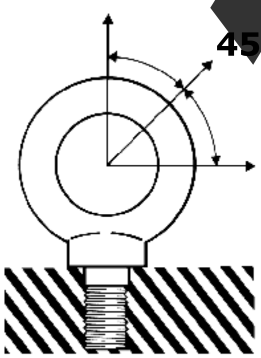
Use plain or regular eye bolts (non-shoulder) or ring bolts for vertical loading only. Angle loading on non-shoulder bolts will bend or break them.

Use shoulder eye bolts for vertical or angle loading

Each eyebolt shall be marked to show: name or trademark of manufacturer; size or rated load; and grade for alloy eyebolts



Never reeve through two eye bolts. It will increase the stress on the eye bolt even more.



Complete exercise #1

Use eye bolts at a horizontal angle greater than 45°.

Sling strength at 45° is 71% of vertical sling capacity.

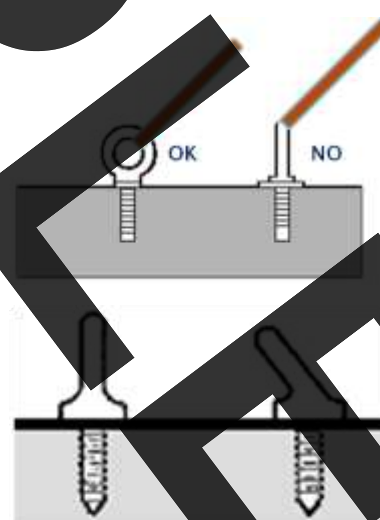
Eye bolt strength at 45° horizontal angle drops down to 30% of vertical lifting capacity.

For shouldered eye bolts, it is ok to side pull, but the capacity will be greatly reduced.

Never pull opposite the plane of the eye, it will deform.

Screw the eye bolt on all the way down and properly seat.

Orient the eye bolt in line with the slings. If the load is applied sideways, the eye bolt may bend.



Eye bolt

Inspect and clean the eye bolt threads and the hole.

Ensure the tapped hole for a screw eye bolt has a minimum depth of one-and-a-half times the bolt diameter.

Install the shoulder at right angles to the axis of the hole. The shoulder should be in full contact with the surface of the object being lifted.

Pack washers between the shoulder and the load surface to ensure that the eye bolt firmly contacts the surface.

Ensure that the nut is properly torqued.

Engage at least 90% of threads in receiving hole when using shims or washers.

Never side load an un-shouldered eye bolt. It will deform.

Attach only one sling leg to each eye bolt.

Do not use a single eye bolt to lift a load that is free to rotate.

Do not use eye bolts that have worn threads or other flaws.

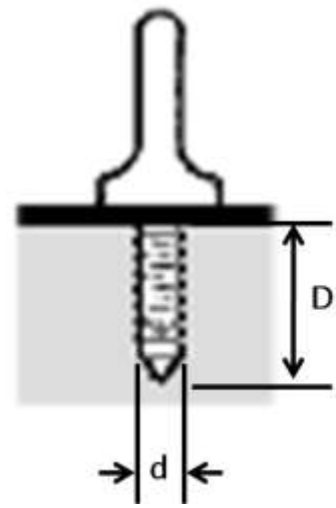
Do not force the slings through eye bolts.

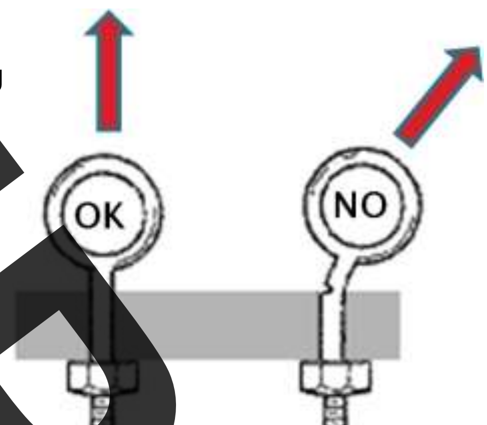
Do not use bars, grips or wrenches to tighten eye bolts.

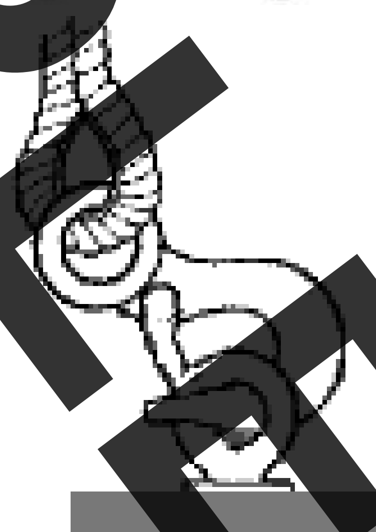
Do not paint an eye bolt. The paint could cover up flaws.

Do not force hooks or other fittings into the eye; they must fit freely.

Never attempt to fabricate your own eye bolts.





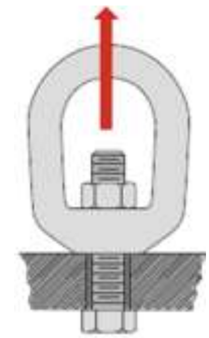


Eye nuts

Eye nuts mainly differ from eye bolts because the bolt is separate from the eye.

Use for vertical picks only.

Must be load rated.



Eye nuts should have full thread engagement and be secured against rotation during lifting.

The threads of the eye nut shall be fully engaged.

Eye nuts shall only be used for in-line loads.

The plane of the eye may be positioned with a flat washer(s) or lock nut.

Components shall be in good working condition prior to use.

Shock loading should be avoided.

Swivel hoist rings

Each swivel hoist ring shall be marked to show: name or trademark of manufacturer; rated load; and torque value.

Use a swivel hoist ring for angled lifts.

The swivel hoist ring will adjust to any sling angle by rotating around the bolt and the hoisting eye pivots 180°.

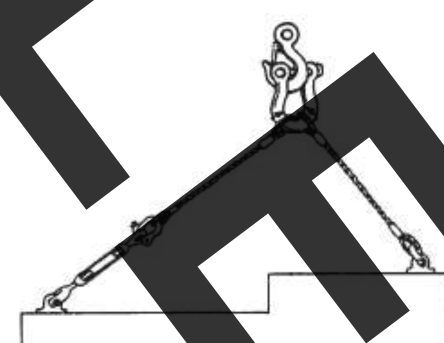
The capacity is the same at every angle.

Turnbuckles

Turnbuckles are adjustable devices consisting of three primary components: a body, a right-hand threaded end fitting, and a left-hand threaded end fitting.

As the body is turned, the length of the turnbuckle increases or decreases.

The main purpose of turnbuckles in rigging is to help rig loads where different length sling legs are needed so the hook can be positioned over the center of gravity.

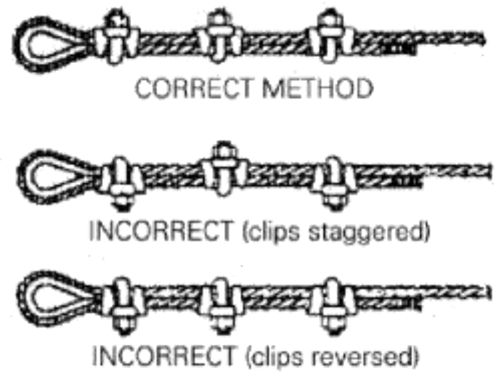


Wire rope clips

Wire rope clips are fittings for clamping two parts of wire rope of the same diameter to each other by compressing the wire ropes between a saddle and a U-bolt or between two saddles, and can be useful for making eyes in the crane hoist line to terminate the line to the boom tip or crane block, although a wedge socket is better suited.

Each new wire rope clip saddle shall have forged or die stamped markings by the manufacturer to show: name or trademark of manufacturer; and size.

In rigging ASME standards mainly discourages using wire rope clips to form eyes in wire rope slings or to join the ends of wire rope to form an endless sling *"except where the application of slings prevents the use of prefabricated slings and where the specific application is designed by a qualified person."*



Wire rope clip assembly

Before installing a wire rope clip on plastic coated or plastic impregnated wire rope, consult the wire rope clip manufacturer, wire rope manufacturer, or a qualified person.

For U-bolt clips used to create end terminations, the saddle shall be placed on the live end of the wire rope, with the U-bolt on the dead-end side.

At least the minimum number of clips as recommended by the manufacturer or a qualified person shall be used.

The spacing and turn-back should be as recommended by the manufacturer or a qualified person.

The wire rope clip shall be tightened to the torque recommended by the manufacturer or a qualified person.

After assembly, the connection shall be loaded to at least the expected working load.

After unloading, wire rope clips shall then be retightened to the torque recommended by the manufacturer or a qualified person.

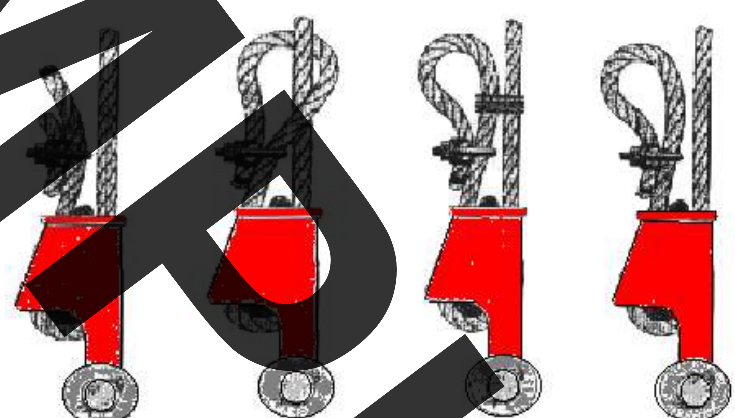
Wedge sockets

Wedge sockets, also commonly called beckets, are useful for "dead-ending" the hoist line to the headache ball assembly, main block or boom tip. They are easy to assemble and disassemble when changing out blocks.

Each new wedge socket body and wedge shall have forged, cast, or die stamped marking by the manufacturer to show: name or trademark of manufacturer; size; model, if required to match wedge to body.

The most common mistake when assembling wedge sockets is to wire rope clip the dead end to the live end. Many wedge sockets have an extended wedge with a hole in it to attach the wire rope clip to.

Here are several ways to terminate the wedge socket. For regular non-rotation resistant wire rope the "tail" needs to be at least 6 inches or 10 times the diameter of the wire rope.



For rotation resistant wire rope it needs to be at least 20 times the diameter of the wire rope.

Wedge socket assembly

The live end of the wire rope in the wedge socket cavity shall be in alignment with the socket's pin.

The assembler shall match the proper wedge and socket for the wire rope.

The dead end of the wire rope shall not be secured to the live end of the wire rope such that it restricts the movement of the live end.

After assembly, the connection shall be loaded to fully seat the wedge before use.

Rings, links & swivels

Master rings are useful for fabricating sling bridles to prevent sling eyes from bunching up on the hook. It is important that they can be traced back to a manufacturer for the load rating or have the load rating stamped on them. Never use a master ring that is homemade or has no identification markings.

Swivels are positioning hardware and are not intended to swivel under a load.

Each new link, ring, and swivel shall be marked by the manufacturer to show
(a) name or trademark of manufacturer
(b) size **or** rated load
(c) grade, if required to identify rated load

Swivels are positioning hardware and are not intended to be rotated under load.

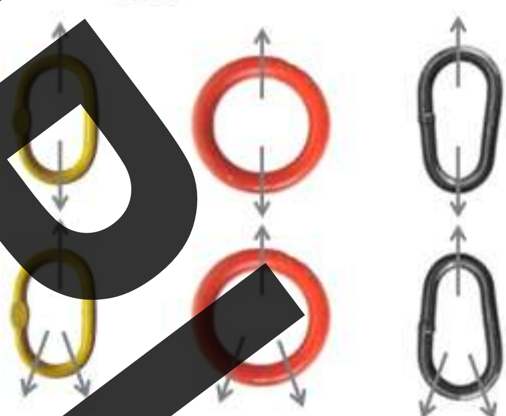
Swivels shall only be used for in-line loads.

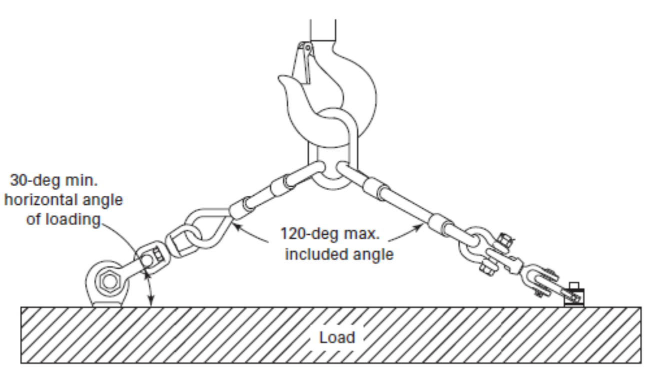
Components shall be maintained in good working condition.

Shock loading should be avoided.

Swivels shall be of the proper shape and size to ensure that they seat properly in the hook, lifting device, or rigging hardware.

Contact with obstructions that could damage the swivel should be avoided.





Master rings can be side loaded up to a 120° included angle.

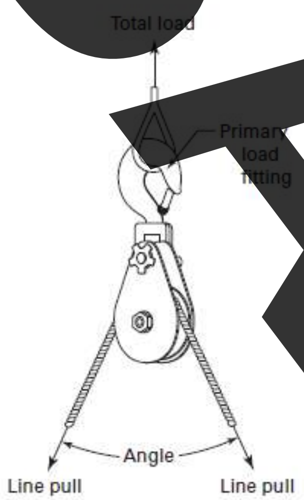
Although master rings can be side loaded up to 120° included angle it will see twice the stress of a vertical pick.

Never use sling angles less than 30° unless approved by a qualified person.

Rigging blocks

Rigging blocks are used mainly on cranes to increase the effectiveness of the winch. These blocks range from one-sheave blocks up to 10 sheave blocks on larger cranes.

Snatch blocks are sometimes attached to the boom tips that just have one sheave that will allow the crane to be configured into a 3 part line pull.



Tackle Block Angles

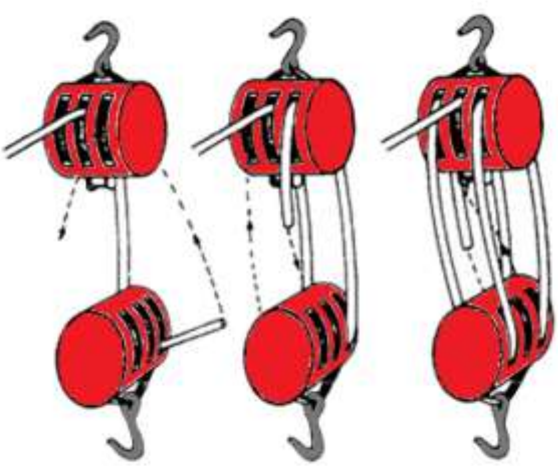
Angle	Factor
0	2.00
10	1.99
20	1.97
30	1.93
40	1.87
50	1.81
60	1.73
70	1.64
80	1.53
90	1.41
100	1.29
110	1.15
120	1.00
130	0.84
140	0.68
150	0.52
160	0.35
170	0.17
180	0.00

The angle of the hoist line as it wraps around the sheave determines how much load the block sees.

The load that the block will see = line pull x load angle factor

Complete exercise #2

Block reeving



In reeving a simple tackle, lay the blocks a few feet apart. The blocks should be placed down with the sheaves at right angles to each other and the becket ends pointing toward each other.

To begin reeving, lead the standing part of the falls through one sheave of the block that has the greatest number of sheaves. If both blocks have the same number of sheaves, begin at the block fitted with the becket. Then, pass the standing part around the sheaves from one block to the other, making sure no lines are crossed, until all sheaves have a line passing over them. Now, secure the standing part of the falls at the becket of the block containing the least number of sheaves, using a becket hitch for a temporary securing or an eye splice for a permanent securing.

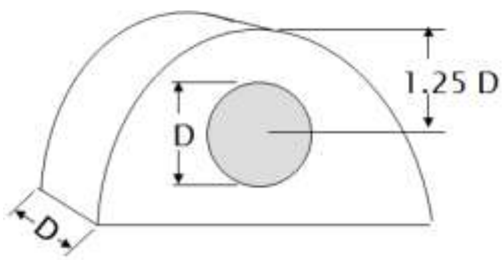
Hooks

Hooks come in all sizes and types. Make sure they are in good working order.

Safety latches are required to be on the hook unless it would present a hazard for the type of lifting you are doing. Make sure the swivel works and is not worn.

Always have replacement safety latch kits on hand.

Weld on lugs



Should be made of forged alloy steel or carbon steel and attached with grooved or fillet welds. The groove weld gives a strong joint between the lug and the object it is welded to. Just as eye bolts are damaged by side pulls, the integrity of weld-on lugs are also compromised.

Rule of thumb: If a shackle with a pin diameter 'D' is used to its maximum capacity, the pad eye dimensions as shown should be used.

Other factors such as sling angle, direction of sling pull in relation to the plane of the eye, type of metal, and welding procedure impact the strength of the eye.

D-rings

A lot of questions come into play when using weld-on D-rings for lifting. Are they load rated? Were they installed correctly? What was the condition of the steel plate they were welded to.

D-ring components should be made of forged alloy steel or carbon steel and attached with either a grooved or fillet weld.

Most off-the-shelf D-rings are rated for pulling rather than lifting. The rated load for pulling is only half the breaking strength where most lifting devices have at least a 5:1 design factor.

Never use non rated pick points for lifting. If unsure, consult a qualified engineer. D-rings should never be side loaded.

Below-the-hook lifting devices

There are no end to the number of specialty below-the-hook lifting devices that are used for lifting. Most are available from different distributors and others are designed for individual lifts by qualified engineers.

The terms lifting beam and spreader bar are often used interchangeably, but, technically, they are different.

Lifting beams have a pick point (sometimes adjustable) that is attached to the beam and are useful where overhead space is limited. The beam must be strong to withstand bending since the pick point is attached somewhere toward the center.

Spreader bars can also be adjustable but the pick points are toward the end of the bar and the middle part of the bar does not support the load but spreads the slings outward and so don't need to be as sturdy.

Lifting beams and spreader bars should be designed and fabricated by a qualified person and clearly marked with their weight and designed working loads

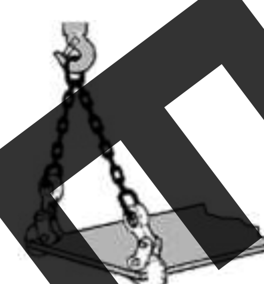
Always follow manufacturer instructions and only use them for their intended purpose.

Plate clamps & lifters

Plate clamps are useful for lifting steel plates vertically. Be sure to lock clamp before lifting the load. For long or flexible loads two or more clamps should be used. Always refer to the manufacturer's user manual before use. Inspect thoroughly before each use.

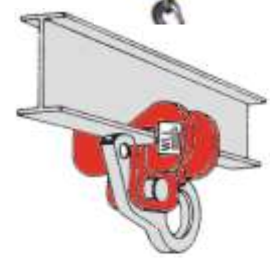
Horizontal steel plate lifting clamps are always to be used in pairs and are only for lifting steel plate horizontally, never vertical.

The advantage of lifting magnates are the quickness of the set-up. Simply center the magnate on the load and turn the lever to engage the magnate.



The load rating is different for flat loads as opposed to rounded loads. Rounded loads will reduce the capacity to less than half.

Below-the-hook lifting devices



Beam clamps provide a very secure anchorage point if used correctly. They are commonly available with capacities up to 12 tons and have various jaw widths. Most beam clamps are designed for use at 90° to the flange. For applications requiring an angle loading, make sure that the clamp is designed for it and that the beam can withstand it.

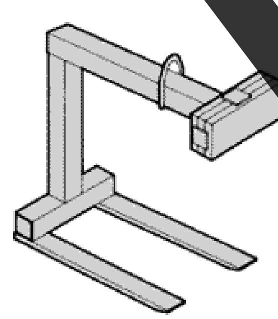
Be particularly careful that the load does not deform the flange. This is most likely to occur with light sections where the flange is wide and thin. Beam clamps should be centered on the beam flange and properly seated. Manufacturers are required to mark beam clamps with working load limits but the ratings apply only to the clamps. The capacity of the beam must be evaluated separately.

Beam clamps are also used to lift beams.

Pipe lifters are useful for lifting pipe without having to dig under it in order to attach the slings. Make sure you use the right lifter for the diameter pipe you are lifting.

C-hook pipe lifters come in all sizes and capacities and can be inserted into the pipe for lifting.

Drum lifters come in hooks, clamps, and lifters. Some will lift the drum vertical and others horizontal.



Pallet forks for use by cranes are very useful for handling palletized loads.

Many automatically adjust to the loads center of gravity.

Lever hoists, chain fall

Lever hoists:
Lever hoists, also known as come-alongs, are a very portable means of lifting or pulling loads short distances. They can be used vertically, horizontally or at an angle in place of a sling or to increase the length of a sling.

A come-along that requires the use of a cheater or the help of another worker to move a load is inadequate for the job. Use a come-along with a larger capacity.

Portable chain hoists:
Chain hoists are useful because the load can be stopped and kept stationary at any point and because of their slow rate of travel, chain hoists allow precise vertical placement. Chain hoists should be rigged so that there is a straight line between the upper and lower hooks.

They are intended for use in a vertical or near vertical position only. If rigged at an angle, the upper hook can be damaged at the shank and the throat may open up. If the gear housing is resting against an object while under load it can be damaged or broken. Always make sure that the hoist is hanging freely.

Chain hoists, come-alongs, and other rigging devices require secure anchorage points. Anchors may be overhead, in the floor, or at lateral points in walls or other structures. The arrangement may involve columns, beams, beam clamps, welded lugs, slings, or block and tackle. Whatever the method, be certain of the loads involved and the anchorage required.

Load indicating devices

Load indicating devices are also known as: load cells; dynamometers; and crane scales. If properly calibrated they take away the guess-work when trying to determine the load weight. Many cranes are equipped with these from the manufacturer.

Portable load indicating devices are wireless and can be installed above the hook.

Prior to use, load indicating devices should be calibrated to within +-2% by the manufacturer or a qualified person.

Their accuracy can be affected by electronic interference or chemically active environments.

Signaling is an important part of crane operation, but is often not treated with the respect it deserves.

Signalers must be used whenever:

- Operator cannot see the load
- Operator cannot see the load's landing area
- Operator cannot see the path of travel of the load or of the crane
- Operator is far enough away from the load to make the judgment of distance difficult
- The crane is working within a boom's length of the approach limits to powerlines or electrical equipment.

Where loads are picked up at one point and lowered at another, two signalers may be required – one to direct the lift and one to direct the descent.

Hand signals should be used only when the distance between the operator and the signaler is not great and conditions allow for clear visibility.

Telephone or radio communications between operator and signaler can be extremely effective.

Who can give crane signals?

A person who is qualified to give crane signals to the operator. This person must be trained and evaluated through a written and practical test.

There should be only one designated signaler at a time. Never start an operation without everyone who is involved in the pick knowing who the designated signal giver is.

If signalers are changing between each other, the one in charge should wear a clearly visible badge of authority. This could be a colored hard hat; highly visible gloves; or a unique vest

The signaler must:

Be in clear view of the crane operator.

Have a clear view of the load and the equipment.

Keep persons outside the crane's operating area.

Never direct a load over a person.

Raise or lower the load

The signal for raising the load is given by raising your arm and rotating your hand with in a large circular motion.

To raise or lower slowly or carefully, put your opposite hand above the other for raising and below for lowering.

Swing the boom

The signal to swing the boom is given by pointing your hand in the desired direction of travel. Try to keep your thumb down so as not to confuse it with the "boom up" signal.

Raise or lower the boom

To give the signal for raising or lowering the boom, hold your arm out to one side and point your thumb up or down with the other fingers folded in.

Telescope in or out

To give the signal to telescope raise your arms in front of you and point your thumbs in towards each other for telescoping in or out and away from each other for telescoping out. So, in reality there are three ways the operator can increase the radius of the crane: Boom down; Telescope out; and on articulating cranes (knuckle cranes), knuckle out, or jib out.

Telescope (one handed)

If you can only use one hand to give this signal then point your thumb inward towards yourself is the signal to telescope out or towards you and pointing your thumb toward the operator signals him to telescope in or towards him.

Stop

The stop signal is given by moving your hand in a sweeping motion away from your body.

Emergency stop

The emergency stop signal is given by swinging both arms out from your body in a sweeping motion and continue until the operation is stopped. Anyone on the site can give this signal if they see something going wrong with the lift.

Dog everything

The signal for dog everything is given by clasping both hands together in front of you, one on top of the other. This signals to the operator that he is to hold everything as is until further notice.

Boom up, wire down

Boom up, wire down is a signal to tell the operator to float the load in. It is given by holding your arm out with the thumb up while opening and closing your hand.

Boom down, wire up

Boom down, wire up is a signal to have the operator float the load out. It is given by holding your arm out with the thumb down while opening and closing your hand.

Knuckle jib

On knuckle cranes, you may need to show which boom you want to have moved up.

Main block

Make this signal by tapping the top of your hard hat. This indicates to the operator that you need the main block.

Whip line

Make this signal by holding your right arm in a square and tapping the elbow with the left hand. Indicates whip line.

Travel left track

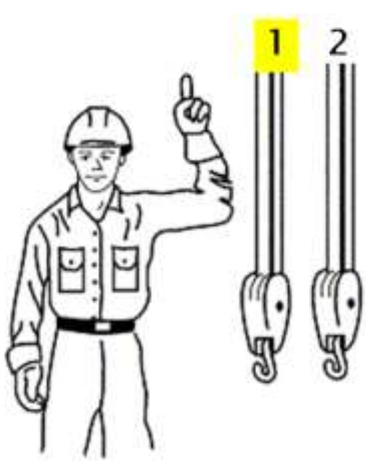
Hold your right arm to the square with your hand closed while turning your left arm in front of you in a circular motion in the direction you want the crane to travel (forward or backward)

Travel right track

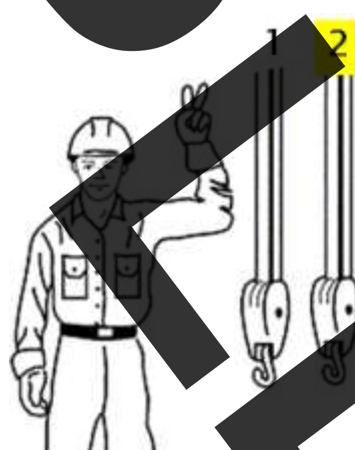
Hold your left arm to the square with your hand closed while turning your right arm in front of you in a circular motion in the direction you want the crane to travel (forward or backward)

Travel both tracks

Turn both arms in front of you in a circular motion in the direction you want the crane to travel (forward or backward)



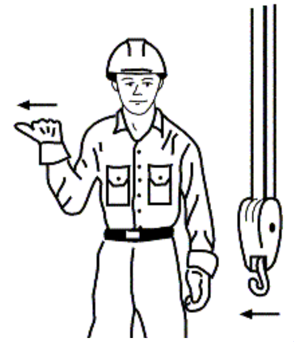
Trolley #1



Trolley #2

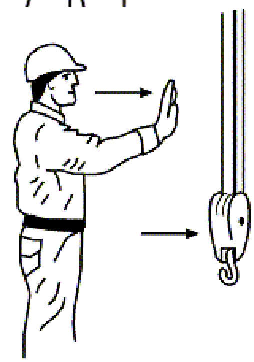
Hand signals

Travel trolley



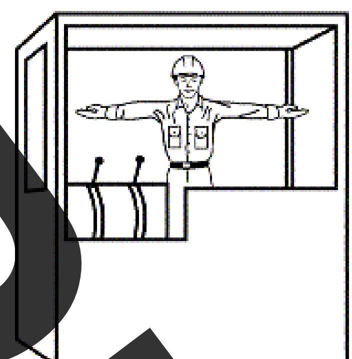
Hold your right arm to the square with your hand closed while turning your left arm in front of you in a circular motion in the direction you want the crane to travel (forward or backward)

Travel bridge



Hold your left arm to the square with your hand closed while turning your right arm in front of you in a circular motion in the direction you want the crane to travel (forward or backward)

Magnate disconnected



Make this signal by holding both hands outstretched with palms up.

Audible signals

When moving the vehicle, the following signals shall be used:

GO FORWARD: two short audible signals

STOP: one short audible signal

BACK UP: three short audible signals

Voice signals

Prior to beginning operations, the operator, signal person and lift director (if there is one), must contact each other and agree on the voice signals that will be used.

Once the voice signals are agreed upon, these workers need not meet again to discuss voice signals unless another worker is added or substituted, there is confusion about the voice signals, or a voice signal is to be changed.

Each voice signal must contain the following three elements, given in the following order: function (such as hoist, boom, *etc.*), direction; distance and/or speed; function, stop command.

The operator, signal person and lift director (if there is one), must be able to effectively communicate in the language used.

For example, if you wanted the operator to boom down slowly, then you would say:

"Boom Down,…. Slowly….Boom stop"

Radio, telephone signals

Signals—radio, telephone or other electronic transmission of signals.

The device(s) used to transmit signals must be fully charged and tested on site before beginning operations to ensure that the signal transmission is effective, clear, and reliable.

Signal transmission must be through a dedicated channel, except:

Multiple cranes/derricks and one or more signal persons may share a dedicated channel for the purpose of coordinating operations.

Where a crane is being operated on or adjacent to railroad tracks, and the actions of the crane operator need to be coordinated with the movement of other equipment or trains on the same or adjacent tracks.

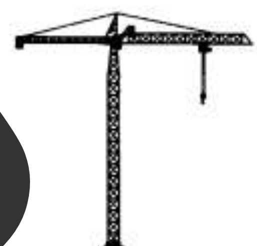
The operator's reception of signals must be by a hands-free system. (the signal person's does not)

Types of cranes

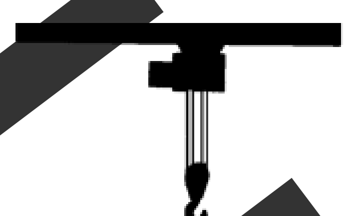
Crane operation carries with it a greater potential for disaster than nearly any other activity on a construction project. Crane accidents are often the most costly construction accidents when measured either in lives or in dollars. All personnel involved in crane operations must understand their jobs, their responsibilities, and their part in the overall safety of each lift.

Mobile Cranes- Found in all industries and range from small industrial cranes (such as Carry-Decks) to crawler cranes that have capacities over 250 tons. The key word is "mobile" and so the work environment continually changes from worksite to worksite.

Tower Cranes- These dot the skyline in industrial and urban areas and because they are high profile they tend to attract the most attention when something goes wrong.



Overhead Cranes- Used in most manufacturing plants, these are the most numerous. They can be as simple as a electric hoist on a trolley on an I-beam or multiple hoists on a bridge crane that spans the whole facility. Outdoors they come in the form of rubber tired gantries or a-frame gantries on rails.



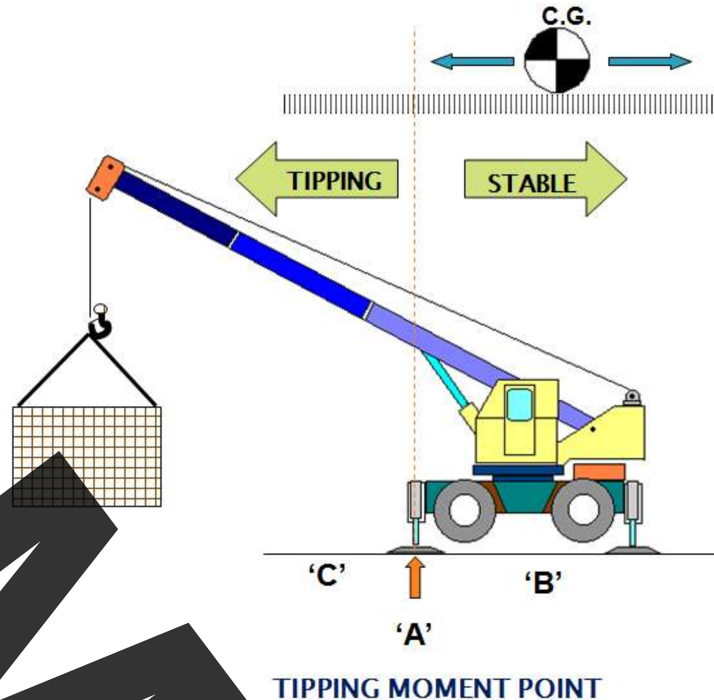
Pedestal Cranes- Mostly used in the maritime industry on docks and vessels.

Crane stability

To completely understand why properly setting up the crane is so important it is necessary to understand crane stability.

Crane stability is based on the principle of leverage. The crane can be viewed as a teeter-totter.

The fulcrum, point A, is similar to the outrigger or tire over which the load is being lifted. When the leverage on side B is greater than the leverage on side C, the crane remains stable. When the leverage on side C becomes greater than on side B, the crane tips over.



The leverage on side B basically depends on whether the crane is operating on rubber or with outriggers extended. When operating on rubber, the leverage is much less than when operating with outriggers extended.

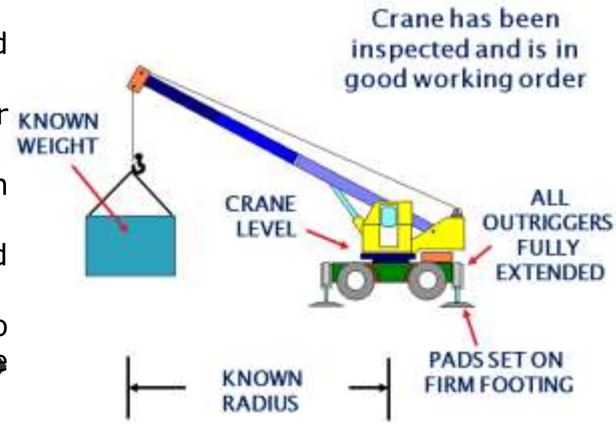
The *amount* the outriggers are extended also affects the amount of leverage generated. The leverage on side C depends on the horizontal distance the load is from point A and the weight of the load. Increasing the horizontal distance and/or increasing the weight of the load increases the leverage on side C. The horizontal distance from point A to the load can be increased by lowering the boom and/or extending the boom.

Over 50% of all mobile crane accidents are the result of mistakes made when the crane was being set up. All of these accidents can be prevented by following the manufacturer's recommendations for assembly, dismantling, by using the correct components, and by observing the precautions outlined in this section.

Crane set up

When setting up the crane, the operator should refer to the operator's manual for specific directions. Consider the following:

- Is the crane in good working order? Has it been inspected and all deficiencies resolved?
- Are the outriggers fully extended and pads on firm footing?
- Is the crane level? The angle indicator and the load chart depends on it.
- Has the weight of the load been established?
- What is the radius of the pick and placement?
- Has the load chart been referenced to determine if the pick is within the capability of the crane?



Crane inspections

ASME standards require frequent and periodic inspections.

OSHA requires cranes to be certified annually in the maritime industry.

Many states and local municipalities require annual certifications.

Crane safety begins with a safe crane. Never use a crane in need of repair.

Are the outriggers fully extended and pads on firm footing?

1. The first consideration is the quality of the surface the crane will be set up on.
2. Soils along the foundation of buildings are often poorly compacted and may contain drain pipe and other voids. Avoid setting up in such areas if possible. If such setup is necessary, use additional floats.
3. Floats larger than the outrigger pads should be used under each outrigger regardless of the type of surface being set up on. Float use will reduce the pounds per square inch loading on the surface.
4. Blocking under the outrigger beam prevents full leverage of the outrigger being utilized. Such blocking increases potential for a tipover.
5. Always extend all outriggers. Not doing so can result in the crane tipping over.

Level crane

Is the crane level? The angle indicator and the load chart depends on it.

All load chart ratings are based on the machine being perfectly level in all directions.

This applies to cranes "on crawlers", "on rubber", "on outriggers" and when travelling with load.

Known load weight

We have already established the fact that the load chart can only be helpful if you have a pretty good idea of the weight of the load.

The most accurate method of determining this is to weigh it.

Often the weight of the load can be obtained from data on manufacturing label plates, manufacturer documentation, blueprints or drawings, shipping receipts, bill of lading, stamped or written on the load and other dependable sources.

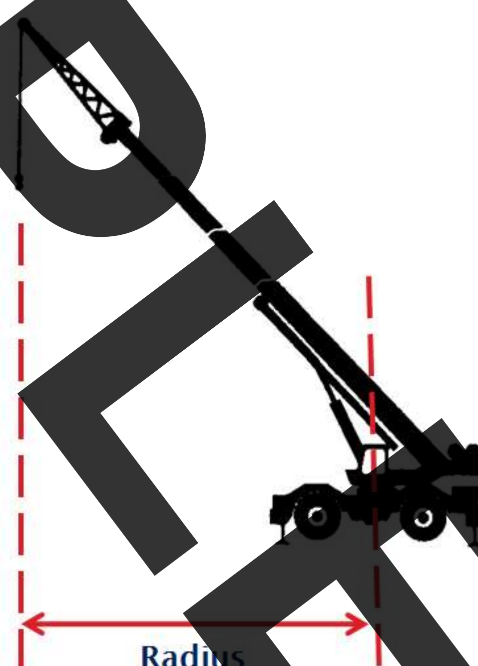
When such information is not available, it will be necessary to calculate its weight. Never use word of mouth to establish the weight of the load.

Crane radius

What is the radius of the pick and placement?

The capacities listed in the load chart also depend on and vary with the crane's load radius. The load radius is the horizontal distance measured from the center of rotation of the crane (center pin) to the load hook (center of gravity of the load) *while* the boom is loaded.

Because of boom and machine deflection and pendant stretch, expect the load radius to increase when the load is lifted off the ground. Expect even larger increases in radius when the crane is "on rubber" because of tire deflection.



Complete exercise #1

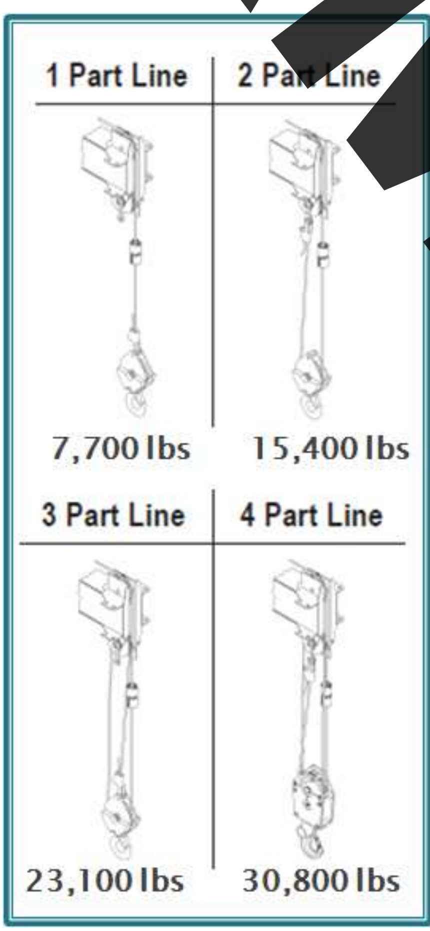
Crane Limits & Hazards

Has the load chart been referenced to determine if the pick is within the capability of the crane?

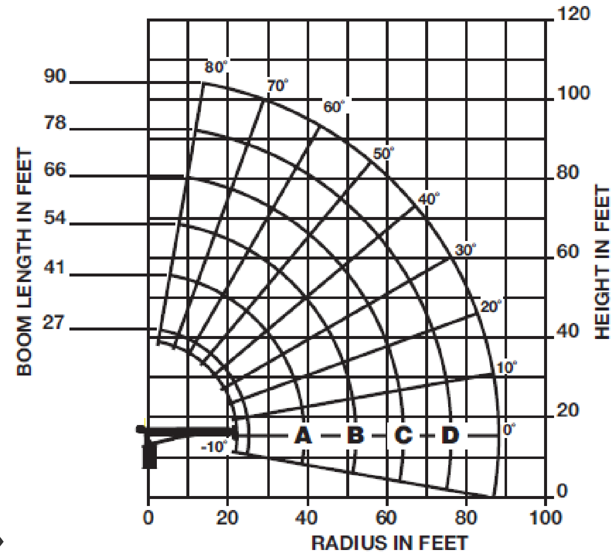
Everything in the set-up of the crane points to the load chart. It is imperative that it be used for every pick and everyone know how to use it. It is more than just a load chart.

It will list different configurations, parts line, deductions, jib use, on rubber picks, and limitations.

Don't wait until the crane is on its side to refer to it.



Load charts



Range diagram

Here is the range diagram for this crane. It is useful for determining the amount of boom needed and at what angle for the radius of the pick.

For example, if the radius of the pick was 65 feet the referring to the load chart we could see that the minimum boom length needed would be 78 feet at a 30° angle.

Parts line

Another consideration is the number of parts of line needed for the pick. The crane is limited by the hoist line capacity.

For example: If you are using the crane in a one-part reeving then the most you could pick would be 7,700 lbs. If the load weighed 8,500 lbs, then you would need to use the one-sheave block and go to two-parts line.

Capacity chart

This is a typical load chart that is found on a National 690E boom truck. This load chart coupled with the range diagram will help you to determine if the crane has the capability to make the pick.

LOADED RADIUS (FT)	LOADED BOOM ANGLE (DEG)	27 FT BOOM (LB)	LOADED BOOM ANGLE (DEG)	A 41 FT BOOM (LB)	LOADED BOOM ANGLE (DEG)	B 54 FT BOOM (LB)	LOADED BOOM ANGLE (DEG)	C 66 FT BOOM (LB)	LOADED BOOM ANGLE (DEG)	D 78 FT BOOM (LB)	LOADED BOOM ANGLE (DEG)	90 FT BOOM (LB)
5	77	40,000										
8	70	25,750										
10	66	21,400	74	20,950								
12	61.5	18,450	71	17,750	76	17,000						
14	57	16,400	68	15,250	74	15,000	77.5	14,450				
16	51	14,750	65.5	13,300	71.5	13,200	75.5	12,600				
20	40	11,250	58.5	10,800	67.5	10,500	72	9,950	76	9,700	77.5	7,850
25	19	7,500	50	9,050	61.5	8,150	67	7,900	71.5	7,750	74.5	7,550
30			40	7,550	55	6,750	62.5	6,450	68	6,250	71.5	6,150
35			26.5	5,250	48	5,700	58	5,450	63.5	5,200	68	5,050
40					40	4,600	52	4,550	59.5	4,400	64.5	4,200
45					32	3,850	46.5	3,850	54.5	3,700	61	3,550
50					16.5	2,450	39.5	3,150	50	3,150	57	3,000
55							31	2,550	44.5	2,650	53.0	2,550
60							21.5	1,800	39.5	2,250	48.5	2,150
65									32.5	1,750	44	1,850
70									24	1,250	39	1,500
75									11	450	33	1,150
80											26.5	800
85												
	0	4,150	0	1,950	0	850						

Here are the deductions that must be added to the load weight. For example, if you are using a two sheave block then you would need to add 355 lbs to the load before referring to the load chart. (Many load charts also make deductions for a stowed jib)

LOADLINE EQUIPMENT DEDUCT (lb)	
Downhaul weight	150
One sheave block	200
Two sheave block	355

Complete exercise #2

Working around powerlines

Typically, the higher the lines are from the ground, the more voltage. For 50,000 volt lines no part of the crane should come within 10 feet.

If there is a chance for any part of the crane will get close to that distance, protective measures must be taken. You must take these measures unless you have controlled the hazard by de-energizing or moving the lines, or by re-routing the electricity around the work.

Required Clearances	
50kV	10 ft
50 to 200kV	15 ft
200 to 350kV	20 ft

High voltage electrocution is the largest single cause of fatalities associated with cranes. All can be prevented. The power company or utility may consider (if given advance notification) shutting down the line temporarily or moving the line. If that is not possible the following procedures should be enforced:

Working around powerlines

1. **Keep your distance.** Surrounding every live powerline is an area where an electric arc is capable of jumping from the powerline to a conductor of electricity. So you must keep all of your equipment and its load at least the **minimum permitted distance** away from the powerline.

2. **Treat all powerlines as live** until reliable information assures you that the lines are de-energized.

3. **A competent worker must be designated as a signaler** to warn the operator when any part of the equipment, load, or hoist line approaches the minimum permitted distance to a powerline. The signaler must be in full view of the operator and have a clear view of both the equipment and the electrical conductor.

4. **Avoid using tag lines.** Unless it is necessary to prevent the load from spinning into the minimum distance to a powerline, the tag line itself can be a hazard because it can swing into the minimum distance. **Note:** All ropes are capable of conducting electricity, but dry polypropylene has better insulating properties than most commercially available ropes.

5. **Slow down the operating cycle** of the machine by reducing hoisting, booming, swinging, and travel speeds.

6. **Exercise caution when working near overhead lines having long spans** as they tend to swing laterally in the wind and accidental contact could occur.

If you make contact with power lines:

Stay on the equipment. Don't touch the equipment and the ground at the same time. In fact, touching anything in contact with the ground can be fatal. Only if a new hazard develops that could be life-threatening, should you consider leaving the machine.

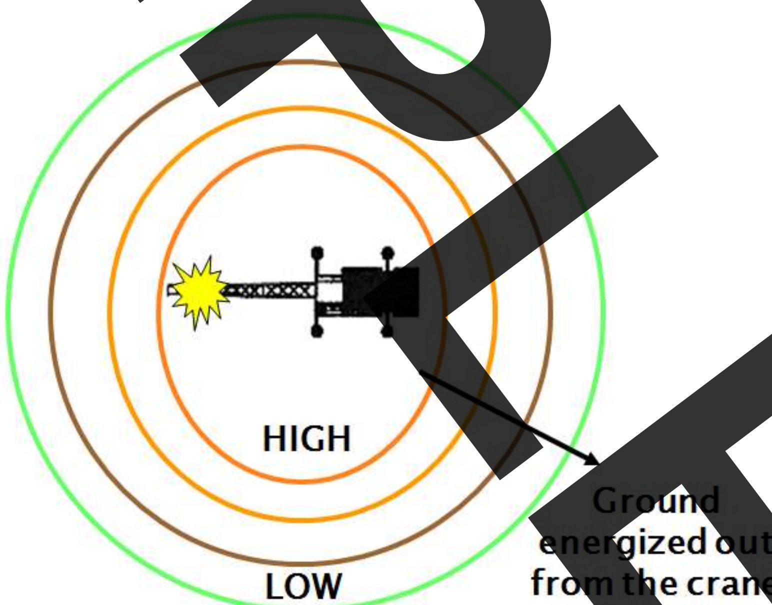
Keep others away. No one else should touch the equipment or its load – including buckets, outriggers, load lines, or any other part of the machine. Beware of time delayed relays: Even after electrical contact trips the breakers, relays may still try to restore power. They may come on automatically two or three times.

Break contact. If possible – while remaining inside the machine – the operator should try to break contact by moving the equipment clear of the wires. This may be impossible if contact has welded conductors to the equipment.

Leaving the machine. If the operator decides to leave the machine, he must jump clear. He must never step down allowing part of his body to be in contact with the ground while any other part is touching the machine.

Ground around machine may be energized. The ground around the machine may be energized make sure no one approaches the machine and if the operator leaves the machine he must not create a voltage path from one leg to the other by taking long steps. Shuffle your feet or hop, keeping both feet together.

Voltage path



Crane Limits & Hazards

Anytime you are going to hoist personnel, there should be a safety meeting to discuss the hazards. Crane suspended personnel platforms are difficult to maneuver and should not be used unless there is no other practical way.

The platform should be load rated and built to OSHA/ASME standards.

The platform should be load tested to 125% of maximum capacity to the location that needs accessed before the live lift is made.

The operator shall only respond to the signal-giver inside the platform.

The crane must be equipped with an anti-two-block device.

The slings used with the platform must be dedicated for that use and be rated to at least twice the capacity of the platform.

Hoisting personnel

Conclusion

Safety is the responsibility of everyone involved. Labor and management both have a responsibility to ensure the safety of all parties involved in hoisting and rigging.

Major rigging operations must be planned and supervised by competent personnel to guarantee that the best methods and most suitable equipment are employed.

It is imperative that all workers who prepare, use, and work with or around hoisting and rigging equipment are well trained in both safety and operating procedures.

Signalman/Rigging Training Student Manual